Certification Training for Operators of Animal Waste Management Systems: Type A

This publication has been prepared in cooperation with the North Carolina Department of Environmental Quality in compliance with a legislative mandate of the North Carolina General Assembly and in cooperation with the Department of Crop and Soil Sciences at NC State University, NC State Extension, the Natural Resources Conservation Service, the North Carolina Department of Agriculture and Consumer Services, and the North Carolina Farm Bureau Federation.

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Appendix A—Permits
NPDES General Permit Number NCA2000000 (Swine)
ncdenr.s3.amazonaws.com/s3fs-public/NCA200000Swine08302016.pdf

State General Permit Number AWG100000 (Swine)

Appendix B—Rules and Checklists
15A NCAC 2T – Wastes Not Discharged to Surface Waters
reports.oah.state.nc.us/ncac/title%2015a%20-%20environmental%20quality/chapter%2002%20-%20environmental%20management/subchapter%20t/subchapter%20t%20rules.pdf

15A NCAC 8F – Certification of Operators—Animal Waste Operator

Operator in Charge Designation Form—Animal Waste OIC Designation Form

Contract Operators Annual Report Form
ncdenr.s3.amazonaws.com/s3fs-public/Water%20Quality/Operator_Certification_Files/WW_Files/Contract_Operator_Req_Form-2014-06.doc

15A NCAC 2D. Section .1800 – DAQ Odor Rules
15A NCAC 02D .1801—Definitions
reports.oah.state.nc.us/ncac/title%2015a%20-%20environmental%20quality/chapter%2002%20-%20environmental%20management/subchapter%20d/15a%20ncac%2002d%20.1801.pdf

15A NCAC 02D .1802—Control of Odors from Animal Operations

15A NCAC 02D .1803—Best Management Plans for Animal Operations

15A NCAC 02D .1804—Reporting Requirements for Animal Operations
15A NCAC 02D .1805—Implementation Plan

15A NCAC 02D .1806—Control and Prohibition of Odorous Emissions

15A NCAC 02D .1807—Determination of Maximum Feasible Controls for Odorous Emissions

15A NCAC 02D .1808—Evaluation of New or Modified Swine Farms

Odor Control Checklists – Swine and Poultry

Appendix 1.1D Swine Odor Control Checklist

Appendix 1.1E Poultry Odor Control Checklist

Insect Control Checklist

Appendix 1.1F Insect Control Checklist for Animal Ops

Leased Land Agreement: Exhibit B – Waste Utilization Agreement ** (entire document)
efort.sc.egov.usda.gov/references/Agency/NC/Archived_NC633Fieldreleaseversion_acidicsoilsFeb09_131031.pdf

Appendix C—Tools

Waste Sample Information Sheet, Form AD9
www.ncagr.gov/agronomi/pdffiles/iswaste.pdf

Soil Sample Information Sheet, Form AD1
www.ncagr.gov/agronomi/documents/AD1_April2015rev.pdf

The North Carolina Phosphorus Loss Assessment Tool (PLAT)
content.ces.ncsu.edu/the-north-carolina-phosphorus-loss-assessment-tool-plat

Deep Soil Sampling for Nutrient Management
content.ces.ncsu.edu/deep-soil-sampling-for-nutrient-management
Plant Sample Information Sheet, Form AD4

Forage Analysis Form
www ncagr.gov/fooddrug/forms/documents/ForageForm.pdf

Appendix D—Operation
Lagoon Data Form
FRBD-1, FRBD-1A
ncdenr.s3.amazonaws.com/s3fs-public/Water Quality/Aquifer Protection/AFO/Reporting Forms/Waste Structure Freeboard and Daily Precipitation Record (FRBD-1, FRBD-1A).xlsx

Resource List of Experts
NCDA&CS Agronomic Field Services
www.ncagr.gov/agronomi/rahome.htm

DWR Regional Offices
deq.nc.gov/contact/regional-offices

NC Cooperative Extension
ces.ncsu.edu

NC NRCS
www.nrcs.usda.gov/wps/portal/nrcs/main/nc/contact

NC DSWC
www.ncagr.gov/SWC/tech/animalwaste.html

NRCS Closure of Waste Impoundments Standard
www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_025881.pdf

Animal Waste Storage Pond and Lagoon Closure Report Form PLC-1

Useful Web Sites for Operators
Attached

Appendix E—Application Aids
Plan of Action for Lagoon Sludge Reduction

Sludge Survey Methods for Anaerobic Lagoons
Certification Training for Operators of Animal Waste Management Systems

Sludge Management & Closure Procedures for Anaerobic Lagoons

Appendix F—Record Keeping

Notification of Change of Ownership Form
ncdenr.s3.amazonaws.com/s3fs-public/Water%20Quality/Aquifer%20Protection/AFO/Application%20Forms/DWR_AFO_ApplicationForm/Change%20of%20Ownership%20Form%202006-12-2015.pdf

Change of Swine Integrator Registration Form
ncdenr.s3.amazonaws.com/s3fs-public/Water Quality/Aquifer Protection/AFO/Other Reporting Forms/ChangeOfSwineIntegratorRegistrationForm8-1-13.doc

Inspection Form
Attached

Appendix G—Safety and Emergencies

Plan of Action for High Freeboard at Animal Facilities

Plan of action cover letter
ncdenr.s3.amazonaws.com/s3fs-public/Water Quality/Aquifer Protection/AFO/Other Reporting Forms/HighFreeboardPOA_CoverLetter8-1-13.doc

Plan of action 5-day drawdown form
ncdenr.s3.amazonaws.com/s3fs-public/Water Quality/Aquifer Protection/AFO/Other Reporting Forms/HighFreeboardPOA5DAY.doc

Plan of action 30-day drawdown form
ncdenr.s3.amazonaws.com/s3fs-public/Water Quality/Aquifer Protection/AFO/Other Reporting Forms/HighFreeboardPOA30DAY.doc

Emergency Action Plan
Attached

Example Notice of Discharge

Example of Animal Spill Press Release

Update on Management of Catastrophic Mortalities (November 2016)
Attached

Attached

North Carolina Guidance for Composting of Mass Animal Mortality (October 2016)
Attached
**Common Abbreviations**

ac = acre(s)
ac-in. = acre-inch
BMP = best management practices
CAWMP = Certified Animal Waste Management Plan
cc = cubic centimeters
CEC = cation exchange capacity
Cu = copper
ft = feet or foot
ft2 = square feet or sq ft
ft3 = cubic feet or cu ft
gal = gallon(s)
gpm = gallons per minute
G.S. = General Statutes
hr = hour(s)
in. = inch(es)
in./hr = inches per hour
lb = pound(s)
lb/1,000 gal = pounds per thousand gallons
lb/ac = pounds per acre
meq = milliequivalents
min = minute(s)
mph = miles per hour
N = nitrogen
NPDES = National Pollutant Discharge Elimination System
OIC = Operator in Charge
P = phosphorus
PAN = plant-available nitrogen
PLAT = Phosphorus Loss Assessment Tool
psi = pounds per square inch
WUP = Waste Utilization Plan
Zn = zinc
Agency Abbreviations

DAQ = Division of Air Quality
DEQ = Department of Environmental Quality
DSWC = Division of Soil and Water Conservation
DWR = Division of Water Resources
EPA = Environmental Protection Agency
NCDA&CS = North Carolina Department of Agriculture and Consumer Services
NCSU = North Carolina State University
USDA-NRCS = U.S. Department of Agriculture - Natural Resources Conservation Service
WPCSOCC = Water Pollution Control System Operators Certification Commission
USGS = United States Geological Survey

Conversion Factors

1 acre-inch = 27,154 gallons
1 acre = 43,560 square feet
lane spacing for traveling gun = 70% to 80% of wetted diameter
lane spacing for stationary gun = 50% to 65% of wetted diameter
Important formulas—Type A

1. Precipitation (application) rate for stationary equipment, inches per hour

\[
\text{Precipitation rate (in/hr)} = \frac{96.3 \times \text{sprinkler flow rate (gpm)}}{\text{sprinkler spacing (ft)} \times \text{lateral spacing (ft)}}
\]

2. Time of irrigation system operation for stationary systems (hours)

\[
\text{Time of operation (hr)} = \frac{\text{application volume (in)}}{\text{precipitation (application) rate (in/hr)}}
\]

3. Application volume (depth) for traveling gun (inches)

\[
\text{Application volume (in)} = \frac{19.3 \times \text{sprinkler flow rate (gpm)}}{\text{lane spacing (ft)} \times \text{travel speed (in/min)}}
\]

4. Travel speed for traveling gun; inches per minute

\[
\text{Travel speed (in/min)} = \frac{19.3 \times \text{sprinkler flow rate (gpm)}}{\text{lane spacing (ft)} \times \text{application volume (in)}}
\]

5. Coverage area for application (manure spreaders and honeywagons)

\[
\text{Coverage area (acres)} = \frac{\text{length (ft)} \times \text{width (ft)}}{43,560 \text{ ft}^2/\text{acre}}
\]

6. Application rate for spreader

\[
\text{Application rate for spreader (gal/acre)} = \frac{\text{spreader load volume (gal)}}{\text{coverage area (acres)}}
\]

7. Determination of spreader capacity

\[
\text{Spreader load (tons)} = \frac{\text{weight of 5 gal manure} \times 1.5 \times \text{spreader capacity (ft}^3)}{2,000}
\]
Formulas That Are Part of Waste Application Record Forms

A. Volume per acre (gallons per acre) for irrigation systems

\[
\text{Volume per acre (gal/ac) = } \frac{\text{Number of sprinklers operating x flow rate per sprinkler (gpm) x run time (min)}}{\text{Acres irrigated (ac)}}
\]

B. Volume per acre (gallons per acre) for pump and haul systems

\[
\text{Volume per acre (gal/ac) = } \frac{\text{Number of loads x volume per load (gal)}}{\text{Acres covered (ac)}}
\]

C. Volume per acre (tons per acre) for solid manure spreader systems

\[
\text{Volume per acre (tons/ac) = } \frac{\text{Number of loads x weight per load (tons)}}{\text{Acres covered (ac)}}
\]

D. Pounds of plant available nitrogen (PAN) applied per acre (lb PAN/ac) for liquid wastes

\[
\text{Pounds PAN/acre (lb PAN/acre) = } \frac{\text{Waste analysis PAN (lb/1000 gal) x volume per acre applied (gal/acre)}}{1,000 \text{ gal}}
\]

E. Pounds of plant available nitrogen (PAN) applied per acre (lb PAN/ac) for solid wastes

\[
\text{Pounds PAN/acre (lb PAN/acre) = } \text{Waste analysis PAN (lb/ton) x weight per acre applied (tons/acre)}
\]

Other Helpful Formulas

Area of a rectangle

\[
\text{Area of rectangle (ft}^2) = \text{length (ft) x width (ft)}
\]

Area of a circle

\[
\text{Area of circle (ft}^2) = 3.14 \times \text{(circle radius)}^2
\]
Abstract

A proper waste management plan and waste application system are vital parts of a modern confined animal operation. If the waste from your animal operation is not properly managed, it can have many negative impacts on your overall farming operation as well as your community. The negative consequences of a poorly managed waste application system can cost in terms of dollars, loss of land values, impaired environmental quality, and loss of good standing in the community.

The North Carolina General Assembly passed legislation in 1995 and 1996 requiring certification of operators of animal waste management systems. The law requires a certified operator for animal waste management systems that serve over 250 swine, 100 confined cattle, 75 horses, 1000 sheep, or 30,000 poultry with a liquid animal waste management system. To become a certified operator, one must complete an approved training course on the operation of animal waste management systems, pass an appropriate examination, and pay the required fees. This training program is designed to provide operators of animal waste management systems the basic understanding needed to operate and maintain these systems in an efficient and environmentally sound manner. This manual is not intended to provide all of the technical details for the complete design of a waste management system or an approved animal waste management plan. There are many good reference materials that have been published on these subjects that can provide more detailed information if desired. Many of those materials will be referenced to in this manual for basic information. You are encouraged to make use of all appropriate materials in the operation of your animal waste management system.

Acknowledgments

This program is administered by the Water Pollution Control System Operators Certification Commission in conjunction with the North Carolina Department of Environmental Quality and with North Carolina Cooperative Extension.

This manual is a combination of guidance and reference materials gathered from various sources in conjunction with input and expertise from individuals with the following organizations:

- Carolina-Virginia Milk Producers Association
- Individual and Corporate Swine, Poultry, Dairy, and Egg Producers
- Natural Resources Conservation Service
- North Carolina Cooperative Extension Service
- North Carolina Dairy Producers Association
- North Carolina Department of Agriculture
- North Carolina Department of Environment and Natural Resources
- North Carolina Egg Association
- North Carolina Farm Bureau Federation
- North Carolina Pork Producers Association
- North Carolina Poultry Federation
- NC State Extension
- Water Pollution Control System Operators Certification Commission
Notes About This Manual

This manual has been written based on the current laws, rules, and technical guidance available at the time. It is possible, indeed likely, that there will be changes in the laws and technical guidance that apply to animal waste management. You should keep yourself aware of these changes. The organizations and government agencies that are involved in animal waste management will make efforts to inform the individuals who own and operate animal waste management systems of these changes as they occur. However, you are ultimately responsible to ensure that you are operating in compliance with current laws and rules. If you have questions, you should contact the appropriate resource people listed in Appendix D for questions concerning these changes.

Pursuant to G.S. 150B-21.3A, “Periodic Review and Expiration of Existing Rules,” the NC Soil and Water Conservation Commission is in the readoption process for the following rules. Approved changes of these rules may impact guidance currently provided within this manual.

02 NCAC 59E Procedures and Guidelines to Implement the Nondischarge Rule for Animal Waste Management Systems
02 NCAC 59G Approval of Technical Specialist and BMPs for Water Quality Protection

How to Use This Manual

This manual is designed for individuals involved in animal production and the waste management systems that are associated with these operations. Therefore, it is assumed that the reader is at least generally familiar with the components of a waste management system and other basic farming practices.

There are two types of certification for animal waste management system operators: titled Type A and Type B. Type A is for systems that handle liquid, low fiber wastes (such as swine) and Type B is for systems that have high fiber wastes (such as cattle). A separate manual has been developed for each classification of operator. Your instructor will provide the appropriate manual for your training. Upon completion of the training and passing the appropriate examination, you will be eligible for the particular certification type for your interest. In order to be able to operate both types of systems, you must complete each class and pass each appropriate examination.

The following section is the Needs-To-Know document. It lists the abilities and skills that you, as an operator of an animal waste management system, should have in order to properly manage the waste management system on your farm.

As you proceed through each chapter, you will be alerted with an italicized note in the outside margin when you enter a section that gives you the information needed to answer a Needs-To-Know item.

At the completion of each chapter there will be review questions. These are used to emphasize important points and to generate discussion among the course participants. Your instructor may use these questions to review the material presented and to prepare you for the examination.

The focus of the training will be on the nine chapters presented. These chapters explain waste system components, waste utilization plans, proper waste application, regulations, record keeping, safety and emergency action plans, and consequences of improper management.
Following these chapters are several appendices, which provide information that is relevant and important to your operation, including forms and information sheets on how to perform certain required tasks.

**Certification Process**

To become certified to operate a Type A or Type B animal waste management system, you must first successfully complete the approved training program. Second, you must submit an application to the Water Pollution Control System Operators Certification Commission with the appropriate fee attached. Third, you must pass an examination administered by the Water Pollution Control System Operators Certification Commission with a score of 70 percent.

For more information on the certification process and duties of the owner and operator in charge, see Chapter 2. The examination dates and locations will be announced during the training programs.

**Technical Assistance**

This manual provides thorough explanations and calculations that will allow you to operate an animal waste management system under normal circumstances. However, there is a tremendous amount of technical assistance available for the planning, design, operation, and reporting that are all involved with animal waste management. This manual references those sources of technical assistance, and you are encouraged to utilize these resources.

The manual will also refer to an individual called a “technical specialist.” A technical specialist has expertise in one or more components of waste management and is certified as such by the North Carolina Division of Soil and Water Conservation. A technical specialist is the only individual who may legally sign the form that completes an approved animal waste management plan. To develop a waste management plan or have one modified, you must have approval from a technical specialist. Not all individuals referenced in Appendix D are technical specialists, but they are still available to offer guidance in waste management issues.
Needs to Know

Chapter 1: Why Are We Here?—Type A

1A-1 Explain the reasons for and which farms require certified operators for animal waste management systems.
1A-1 Define surface water, groundwater, and hydrologic cycle.
1A-3 Describe what an aquifer is and how groundwater flows.
1A-3 Give examples of point source and nonpoint source pollution.
1A-4 Define the eutrophication process and problems it causes in surface waters.
1A-6 Explain why animal waste is a resource.
1A-7 List several nonproducer concerns (such as community and environmental) of livestock, egg, and milk production.

Chapter 2: Regulations Governing Animal Waste Management Systems—Type A

2A-1 Describe the rules and laws that apply to animal waste management.
2A-2 List the threshold number of animals that require an operation to have an animal waste management permit.
2A-3 Explain what a waste system permit is and describe its general conditions.
2A-3 Define “discharge” of animal waste.
2A-4 Define a 25-year, 24-hour storm.
2A-7 Describe the violations that require mandatory reporting by the owner.
2A-8 Describe the various types of regulatory action that can result from mismanagement.
2A-9 Define Operator in Charge and identify whose responsibility it is to designate an Operator in Charge for an animal operation.
2A-10 Know which commission is responsible for animal waste management system operator certification.
2A-11 Describe the necessary steps required to renew your animal waste management system operator certification.
2A-11 Describe the duties and requirements of an Operator in Charge of an animal waste management system.
2A-12 Describe why the WPCSOCC may take an enforcement action against an operator.

Chapter 3: Components of a Certified Animal Waste Management Plan

3A-1 Explain the difference between a waste management plan and a general permit.
3A-2 Describe the primary goal of the waste utilization plan.
3A-3 List the components in a waste utilization plan.
3A-3 Understand how the amount of animal waste produced on a farm annually is calculated.
3A-6 Define agronomic rate.
3A-6 Describe the priority nutrient concept.
3A-6 Describe the role of vegetation in waste management.
3A-6 List factors to consider in crop selection.
3A-7 Define realistic yield expectation (R.Y.E.).
3A-8 Describe why timing of waste applications is important.
3A-9 List ways in which best management practices protect water quality.
3A-9 Describe the importance of BMP maintenance and describe what to do if a BMP fails.
3A-12 Describe which facilities must perform a phosphorus loss assessment.
Chapter 4: Tools for the Plan—Type A

4A-1 Describe why the proper collection of waste samples is important.
4A-1 Explain how often waste samples must be taken.
4A-1 Describe how to take a waste sample of a lagoon, waste slurry, or dry waste and submit it for nutrient analysis.
4A-5 Describe information available on a Waste Analysis Report.
4A-5 Interpret the waste analysis report and know if lab results are reasonable.
4A-9 Describe how to take a soil sample and submit for analysis.
4A-10 Describe information available on a Soil Test Report.
4A-13 Describe how soil test information can help select a site and determine the sustainability of long-term waste applications.
4A-16 Describe the role of plant tissue and forage analysis in managing and monitoring crop and forage quality.

Chapter 5: System Components and Operation—Type A

5A-1 Describe the purpose and components of a Type A animal waste management system.
5A-1 Describe the function of an animal waste lagoon.
5A-2 Describe the six specific volumes for an anaerobic lagoon.
5A-3 Explain the need and use of a liquid level gauging device.
5A-3 Explain the need for proper pipe design, installation, and maintenance.
5A-8 Define wettable acres.
5A-9 Describe possible causes of lagoon failure.
5A-9 Explain the proper operation of an animal waste lagoon.
5A-10 Explain why water reuse is important.
5A-11 Describe the purpose of surface water diversions.
5A-11 Describe proper lagoon and dam maintenance.
5A-13 Describe the proper operation and maintenance of pumps and pipes.
5A-14 Explain methods to minimize crystal buildup in recycle pipes.
5A-14 Explain how to monitor lagoon sludge levels and develop a sludge Plan of Action.
5A-15 Describe the proper methods of sludge removal.
5A-17 Describe some methods that could be used to enhance waste treatment.

Chapter 6: Proper Application of Waste Products—Type A

6A-1 List the necessary setbacks for waste application.
6A-3 Describe why wind speed and direction should be considered when irrigating.
6A-5 List the four factors that must be addressed before irrigating animal waste.
6A-7 Explain how to determine how much water to irrigate.
6A-8 Explain how/why irrigation amounts need to be adjusted seasonally.
6A-8 Define discharge rate, precipitation rate, and application volume.
6A-8 Explain how to obtain sprinkler discharge rates.
6A-9 Explain how to obtain sprinkler discharge rates.
Chapter 6: Application—Type A

6A-9 Explain what effect changing nozzle diameter can have on discharge rate and wetted diameter.
6A-10 Explain the importance of sprinkler overlap.
6A-11 Compute the precipitation rate for a stationary sprinkler irrigation system.
6A-12 Compute the application volume for a stationary sprinkler irrigation system.
6A-12 Determine the operational time necessary to apply a desired application volume and associated nitrogen application amount.
6A-12 Determine application volume and effective coverage from manufacturer’s literature for a traveling gun sprinkler.
6A-13 Compute the required travel speed for a traveling gun sprinkler to apply the desired application volume.
6A-14 Explain the effects of changing pressure on droplet size, drift, precipitation rate, and wetted sprinkler diameter.

Chapter 7: Record Keeping—Type A

7A-1 Describe the importance of record maintenance.
7A-1 Describe what records need to be maintained to show compliance with environmental regulations.
7A-2 Describe proper record keeping procedures and maintenance.
7A-3 Calculate and verify application rates through the use of waste application records.

Chapter 8: Safety—Type A

8A-1 Describe the health effects of gases associated with livestock buildings and manure storage.
8A-3 Describe the steps for first aid to victims of asphyxiation.
8A-4 Explain the safety precautions for manure storage.
8A-5 Describe several safety precautions in regards to vehicle operation, heavy equipment, PTOs, and hydraulic systems.
8A-6 Describe the lockout/tagout procedure of electrical safety.
8A-8 Give examples of personal protective equipment.
8A-9 Describe the correct way to lift and carry objects.
8A-10 Describe the responsibilities of the site supervisor.
8A-10 List the items that a safety program should include.
8A-10 List the topics that first aid training should include.
8A-11 Describe the responsibilities of the owner or employer.
8A-11 Describe the responsibilities of the employee.
8A-11 Define permit-required confined space entry.
8A-12 Describe the safety actions that must be taken when working in a space that does not require a confined space permit.
8A-12 Describe the components of a basic fire emergency plan.
Chapter 9: Emergencies and Catastrophes—Type A

9A-2 Define Plan of Action for high lagoon levels.
9A-4 Describe the main components of an emergency action plan and why each is necessary.
9A-4 Describe the course of action that should be pursued should an emergency situation develop.
9A-5 List what information should be gathered when assessing the impact of a waste discharge.
9A-5 Explain who to contact and when should problems develop with the waste management system.
9A-6 Describe where the emergency action plan should be located and who should be aware of it.
9A-7 Describe the violations that require mandatory reporting by government agencies.
9A-7 Which agency is responsible for laws and regulations relating to animal mortality.
9A-8 Be familiar with mortality disposal requirements.
Chapter 1: Why Are We Here?—Type A

A key component of a modern animal operation is its waste management system. Although a number of methods of treatment and disposal are under investigation, land application of animal waste is currently the most viable alternative for the treatment and disposal of animal waste.

Land application involves spraying or spreading animal waste on the land surface. Natural physical, chemical, and biological processes treat the waste as it moves into and through the soil, while crops remove nutrients and water.

When properly operated and managed, land application allows safe disposal of animal wastes and beneficial use of the nutrients and water by crops. Sound animal waste management practices reduce risks to human health and the environment, while ensuring that farmers and producers gain the maximum fertilizer value from the byproducts of their animal operations.

However, improperly operated and managed animal waste management systems pose a serious threat to public health and natural resources.

Seeking to safeguard human health and the environment, the North Carolina General Assembly passed legislation in 1995 and 1996 that established a permitting program for animal waste management systems and a certification program for operators of animal waste management systems. This legislation requires the presence of a certified animal waste management system operator for any animal operation in the state with a liquid waste management system serving more than 250 swine, 100 confined cattle, 75 horses, 1,000 sheep, or 30,000 poultry.

Most likely, you have enrolled in this training program because you want or need to become a certified animal waste management system operator. This course of study is intended to provide you with the information you need to become certified. You will learn to operate and manage an animal waste management system in an efficient and environmentally sound manner, without negative impacts on water quality, soils and crops, grazing animals or other consumers of the crops, and with minimal impacts to your neighbors.

Our Water Resources

Water is one of our most essential natural resources. When it occurs on the land in streams, rivers, lakes, etc., it is called surface water, while water under the surface of the land is called groundwater (Figure 1-1).

Surface water is essential for many of our most important activities, including drinking, irrigation, industry, production of electricity, transportation, and recreation. It serves as a habitat for plants and animals, and it recharges (replenishes) groundwater supplies.
Groundwater is equally important. Ninety percent of rural residents and 50 percent of the total population of the United States depend on groundwater for drinking water. In its natural state, groundwater is usually of excellent quality and can be used without costly treatment or purification. It can be inexpensively tapped next to the point of use, saving the cost of transporting water over long distances. In rural areas, groundwater is often the only source of drinking water available.

Surface water and groundwater are part of the **hydrologic cycle**, which is the continuous movement of water in the atmosphere, on the ground’s surface, and under the ground. Water falling from the sky as precipitation either evaporates, soaks into the soil, or travels over the soil surface.

When humidity is low, precipitation may evaporate before it even reaches the ground. More importantly, water evaporates from the soil surface and from leaf surfaces. Evaporation at leaf surfaces occurs as plants draw water and nutrients from the soil into their roots and up into their stems and leaves. This process of water moving upward and through a plant is called **transpiration**. The combined loss of water to the atmosphere by evaporation from the soil surface and by transpiration is called **evapotranspiration**.

Precipitation soaks into the soil by a process known as **infiltration**, which is defined as the downward entry of water into the soil or rock surface. Some water remains close to the soil surface. It can be used by plants or move horizontally through the soil until it emerges into streams, rivers, or lakes and becomes surface water. Some water moves deeper into the ground through the process of **percolation** (the flow of water through soil and porous or fractured rock), becoming groundwater that is stored for long periods of time in **aquifers**.
Aquifers are underground formations of porous rock or stone that store water in cracks or spaces between soil particles. Unlike surface water that flows several feet per second, groundwater in aquifers moves very slowly, maybe only a few feet per month or even per year.

**Runoff** is precipitation that doesn’t evaporate or soak into the soil, but travels over the soil surface until it reaches surface water. Runoff often carries suspended soil particles. This loss or movement of soil is called soil erosion. Conditions such as slope, soil texture, cover crop condition, and soil moisture will affect whether rainfall (or applied wastewater) will soak into the soil or run off.

### Effects of Animal Waste on Water Quality

The use of our water resources themselves can produce pollution. Some of these uses produce pollution that comes from a single identifiable source, such as a pipe through which factories or treatment plants discharge treated wastewater into surface water. This is called **point source pollution**. All activities that produce point source pollution require permits.

Other activities result in the release of pollutants from many different locations. This type of pollution, called **nonpoint source (NPS) pollution**, is more difficult to trace to its point of origin because it takes place over a broad area. Activities that produce nonpoint source pollution include highway, residential and urban development, forestry, agriculture, and animal operations (Figure 1-2). More and more of these activities require permits.

![Figure 1-2. Potential sources of nonpoint source pollution.](image)
When animal waste is applied to the soil surface, it becomes part of the hydrologic cycle and acts much the same as natural precipitation. However, animal waste contains high concentrations of substances that can contaminate surface and groundwater. The substances of greatest concern are nutrients (primarily nitrogen and phosphorus), pathogens, and organic matter.

A nutrient is any substance that promotes growth and can be taken up by plants or consumed by organisms. When land-applied, animal waste can provide crops with essential nutrients, such as nitrogen (N) and phosphorus (P). In excess, however, nutrients can become contaminants that negatively impact both surface and groundwater quality.

If runoff containing excessive amounts of nitrogen (N) and phosphorus (P) reaches surface waters, it can speed up the process of eutrophication. Eutrophication is the slow, natural nutrient enrichment of streams and lakes and is responsible for the “aging” of ponds, lakes, and reservoirs. Excessive amounts of nutrients entering surface waters can accelerate eutrophication and stimulate rapid algae growth or “blooms”.

When the algae die and are decomposed by organisms, the dissolved oxygen in the water is depleted. This condition can result in fish kills, offensive odors, unsightliness, and reduced attractiveness of the water for recreation and other public uses. Massive blooms of cyanobacteria, a type of blue-green algae, can kill livestock and pose health hazards to humans.

Groundwater quality is primarily impacted by nitrogen, in the form of nitrate. Because nitrate is not attracted to soil particles, it is very soluble and mobile in soil. If animal waste is overapplied, nitrate will leach, or flow downward, beyond a crop’s root zone and eventually contaminate groundwater.

The United States Public Health Service has established a specific standard of 10 milligrams of nitrate per liter as the maximum concentration allowable in groundwater. Concentrations in excess of this standard can cause human health problems, particularly for infants.

Although nitrate-contaminated water can affect livestock, the concentrations that produce toxicity are much higher than those for humans. Nitrate-contaminated water is usually a problem only when it adds to high nitrate concentrations already present in some feeds.

Pathogens are viruses, bacteria, or parasites capable of causing infection or disease in humans or other animals. In humans, pathogens can cause severe diarrhea, nausea, fever, vomiting, and even death due to bacteria such as E. coli in animal waste. They are most likely transported with surface runoff and erosion or by direct animal access to surface water. Streams and lakes used for drinking water supply and recreational purposes provide the greatest opportunity for transporting these pathogens to humans. Pathogens in animal waste can also leach through the soil to groundwater, although this is less likely.
Like nutrients, organic matter is a valuable resource if managed properly or a contaminant if managed poorly. Animal waste contains extremely high amounts of degradable organic matter. These products can be 50 to 250 times more concentrated than raw municipal sewage.

Organic matter decomposes rapidly and large amounts of oxygen are used during the process. If untreated or partially treated animal waste enters surface waters, oxygen can quickly be depleted, resulting in fish kills, offensive odors, unsightliness, and reduced attractiveness of the water for recreation and other public uses.

In short, runoff of animal waste carries contaminants to surface waters. Percolation of animal waste below the root zone of crops transports contaminants to groundwater. Therefore, runoff of animal waste is unacceptable. Deep percolation of untreated or partially treated animal waste below the root zone is also unacceptable.

**Treatment and Reuse Through Land Application**

Fortunately, soils and crops function as natural treatment systems. Soils are capable of physically filtering, chemically adsorbing (or retaining), and biologically converting contaminants. However, soils vary greatly in their treatment capacity.

The soil in one field often has different physical and chemical properties than the soil in another field, or on another farm. Landscape features, such as slope, also vary. The properties of the soil and the landscape features present at a specific site determine how land application of animal waste must be managed.

Soils are made up of four basic components: minerals, air, water, and organic matter. The mineral portion consists of three different sized particles: sand, silt, or clay. The relative proportion of sand, silt, and clay in a soil determines its texture. Soil texture is a very important soil property because it strongly influences water-holding capacity, nutrient retention, and contaminant treatment.

Sandy soils allow water to drain rapidly, and contaminants pass through too quickly for significant treatment to occur. In addition, these soils may not hold water and nutrients in the root zone long enough to support a healthy vegetative cover. A poor cover crop can result in an increased potential for erosion and reduced infiltration. Soils with more clay are better suited for holding the waste materials until the nutrients can be used by the crops. As a result, groundwater contamination is less likely in clay soils.

Soil organic matter has a very large absorptive capacity for most pollutants. It contributes to improved infiltration and greater water and nutrient holding capacity. Maintaining an active organic component in the topsoil through good soil and crop management enhances the soil’s capacity to retain contaminants. If the amount of organic matter in a soil decreases significantly due to poor farming practices, the soil’s ability to hold these contaminants is drastically reduced.
Remember that crops are a critical component in the animal waste treatment process. They remove nutrients and water, reduce erosion, and maintain or increase infiltration rates. Crops also vary greatly in their capacity to take up nutrients and to tolerate high soil moisture conditions and in their consumptive use of water and irrigation requirements.

Your job as an operator is to match your waste application rate to both the nutrient needs of the crop and to the rate at which the soil will accept and hold the waste materials. Animal waste must be applied using rates and methods that prevent both surface runoff of pollutants and leaching of pollutants to groundwater. Your goal is for animal waste to infiltrate into the soil and remain in the root zone long enough for contaminants to be treated by the soil and nutrients to be taken up by crops.

**Animal Waste as a Valuable Resource**

Although serious problems can result from its mismanagement, animal waste that is properly managed is a valuable resource. For centuries, it has been recognized as an excellent source of plant nutrients and as a soil amendment. When compared to commercial fertilizers, animal waste has some potential environmental benefits.

First, the nitrogen in animal waste can be more stable than nitrogen applied as commercial fertilizer. Commercial fertilizer N is applied in either a nitrate or an ammonium (easily converted to nitrate) form. Nitrate is very soluble and mobile, and early in the growing season, it contributes to leaching during excess precipitation or irrigation. Some of the nitrogen in animal waste is stored in an organic form that is slowly released as soils warm. It is slowly converted to forms better timed to crop needs, with less potential for leaching below the root zone.

In addition, some nitrogen is released very slowly, often not becoming available until the second or third year after application, thus providing long-term benefits. And finally, production of commercial nitrogen fertilizers is energy intensive. Utilizing the nitrogen supplied by animal waste reduces energy demands.

Phosphorus contained in commercial fertilizers must be commercially mined. There are limited reserves of phosphorus remaining in the United States. Animal waste provides an increasingly important alternative to commercial phosphorus fertilizers and helps conserve this limited resource.

Because it contains organic matter, animal waste applied to the soil can improve soil productivity. Most nutrients that enter the plant root zone need to be converted to plant-available forms by microorganisms. The organic matter in animal waste serves as a source of energy for the soil microorganisms that both stabilize nutrient sources and make those nutrients available to crops. Organic matter in animal waste also increases the infiltration, nutrient retention, and water-holding capacity of a soil, while it reduces soil erosion.
Environmental Stewardship

Recognizing the value of animal waste as a resource is a fundamental principle of environmental stewardship. Managing your animal operation so that it does not negatively impact public health or natural resources is another. There are several more principles that must be considered.

Good Neighbor Policy

Animal waste management systems can create several potential nuisances (including odors, flies, noise, and others) in rural communities. A farmer or producer must be fully aware of these potential problems and the degree of concern they cause neighbors. Where reasonable technologies and management strategies are available to reduce or eliminate these nuisances, such strategies should be considered. Where such options do not exist, producers may need to consider alternatives for offsetting these nuisances.

Awareness of public perception is critical to successful animal waste management. The appearance of your animal operation alone has a large impact on what people think and their perceptions of odor and other nuisances. Because much of the population does not understand what you do in your farm operation, it is important to have good lines of communication to prevent problems from arising. Before you land-apply your waste or perform other activities such as removing sludge from your lagoon, you should consider how your activities can impact the surrounding community.

Your animal operation may be scrutinized by neighbors and by groups like environmental organizations. These individuals and groups strive to maintain their individual standard of living and comfortable surroundings, as well as ensure that their property values and the environment are not harmed. Issues such as odor, loss of property value, and concern for drinking water quality are raised frequently by neighbors of animal and poultry operations.

Good management may help you avoid lawsuits. However, you cannot ignore the potential for nuisances, and it is advisable to develop an individual plan based on your local circumstances that deals with these issues. You should consider ahead of time what course of action you may need to take should you become involved in conflicts or lawsuits concerning your operation.

Production Practices

Your production practices can also be considered a form of environmental stewardship. While it is important to properly manage your system to prevent environmental problems or conflict with neighbors, it is just as important to properly manage your waste management system for your interests.

A good, common-sense rule is that it is far easier to prevent problems than correct them. This old saying is certainly true of animal waste management. Making amends for problems is almost always more costly than proper operation and maintenance.
Having a routine maintenance program for buildings, equipment, and grounds reduces environmental mishaps as well as safety hazards. A well-maintained and clean operation improves herd health, reduces odors, and makes management easier.

Proper application of animal waste will help you protect your farmland’s productive capacity for future use. Considering animal waste as a resource, and using those nutrients properly, can save you fertilizer costs and improve your soil.

Managing your wastes correctly will protect water supplies, which may include the ones you use on your farm for your family and the animals. Once groundwater becomes contaminated, it is nearly impossible to clean up. The only ways to get safe drinking water are to treat the water, drill a new well, or obtain water from another source. All of these options are expensive and inconvenient. Clearly, it is easier to protect our natural resources in the first place than to restore them.

**Knowing the Rules**

Good stewardship also includes knowledge of and compliance with current regulatory requirements as established by federal, state, and local governments. These requirements are discussed next. Bear in mind that most regulations establish minimum standards for protection of public health and the environment. Good stewardship, however, often requires higher standards.

**Animal Waste Operator Training Program**

The training program will focus on:

1. The requirements of the laws and rules.

2. Basic knowledge of water movement and how animal and poultry waste may affect water quality.

3. How to manage and maintain waste management systems including lagoons, storage ponds, land application equipment, and crops.

4. How to take samples of animal waste for waste characterization, and how to sample soils and crops for agronomic purposes.

5. Development and importance of cropping systems that efficiently use the nutrients contained in animal waste.

6. Operation of land application equipment.

7. The need to maintain adequate written records.

8. Timing of land application based on lagoon level, crop needs, weather, and soil conditions.

10. Odor control.

11. Insect control.


15. Availability of technical and educational assistance.
**Review Questions**

1. What is the purpose of the law requiring a certified waste management system operator?
2. Which animal operations are required to have a certified operator?
3. Describe the hydrologic cycle.
4. Why is it important to keep waste products out of surface waters and groundwater?
5. List three reasons animal waste is seen as a valuable resource.
6. Define aquifer.
Chapter 2: Regulations Governing Animal Waste Management Systems—Type A

In the previous chapter, we examined the ways that animal waste can be both a beneficial resource and a pollutant. In this section, we will examine the laws and regulations that set basic standards for the proper operation and management of animal waste management systems.

In 1996, the North Carolina General Assembly enacted Senate Bill 1217. This state law established requirements for training and certifying operators and for permitting animal operations.

In 2003, the United States Environmental Protection Agency (EPA) required North Carolina to begin implementing provisions of the Clean Water Act of 1972. The Clean Water Act is the federal law that established the National Pollutant Discharge Elimination System (NPDES) permitting program (see General NPDES Permit Number NCA200000 in Appendix A).

The Act defined a concentrated animal feeding operation (CAFO) as an animal feeding operation (AFO) that (a) confines animals for more than 45 days during a growing season, (b) in an area that does not produce vegetation, and (c) meets certain size thresholds. Animal operations that met EPA’s definition of a CAFO were required to apply for a NPDES permit. Consequently, many animal operations that were originally permitted under Senate Bill 1217 were required to apply for NPDES permits under the provisions of the Clean Water Act.

In 2008, revised EPA regulations became effective and replaced the 2003 regulations. These revised regulations allowed large CAFOs to choose between coverage under an NPDES permit or a State permit. Almost all of the operations that were required to obtain NPDES permits are now covered under State permits.

Responsibility for implementing the laws and regulations governing animal operations resides with the North Carolina Department of Environmental Quality (DEQ), specifically with its Division of Water Resources (DWR). To carry out the requirements in the state and federal laws, DWR developed state regulations that contain specific requirements for permitting and operator certification (see State General Permit Number AWG100000 in Appendix A).

The permitting and operational requirements for owners of animal waste management systems are found in state rule 15A NCAC 2T (Wastes Not Discharged to Surface Waters). The state regulations containing specific requirements for, and responsibilities of, certified animal waste management system operators are found in state rule 15A NCAC 8F (Certification of Operators of Animal Waste Management Systems) (see Appendix A).
Animal Waste Management System Permits

A permit addresses the compliance needs and operational requirements of an animal waste management system. It is also a legal and binding agreement and is enforceable by law.

The owner of an animal operation is responsible for ensuring that the waste management system is properly operated and maintained and is in compliance with its permit and all related environmental regulations and laws. Ultimately, the owner is responsible for any violations, regardless of who is actually operating the system.

Of course, owners are often certified and operate their own systems. Many owners, however, employ or contract with certified operators to operate their waste management systems. Operators must understand the legal responsibilities and ramifications placed on owners by the permits. Therefore, it is equally important for both owners and operators to know and fully understand the conditions of the permit.

General Permits

Most of the animal waste management system permits that DWR issues are general permits. A general permit is a standard permit that is issued to all operations of a similar type and size. The permit that is issued to any animal operation in that group is identical to permits issued to other operations in that group. Each permit is accompanied by a Certificate of Coverage that is specific to each operation and defines the owner, location, type of facility, and animal capacity for which it is permitted.

State Nondischarge General Permits

Senate Bill 1217 requires State Nondischarge General Permits for animal operations with liquid waste management systems that serve the following number of animals:

- 250 or more swine
- 100 or more confined cattle
- 75 or more horses
- 1,000 or more sheep
- 30,000 or more confined poultry with a liquid animal waste management system

Animal operations that fall below the threshold numbers or animal operation types not listed by Senate Bill 1217 are considered “deemed permitted.” This means that these systems are considered permitted by regulation and are not actually issued a permit. There are no registration or reporting requirements, and state inspections are performed only if there is a complaint to the regulatory agency (DEQ). These operations maintain their “deemed permitted” status as long as they do not discharge animal waste. Loss of “deemed permitted” status is a situation that these facilities should make every effort to avoid because the result is that the facility would then be subject to all of the same permit requirements as the subject operation types listed above.
Senate Bill 1217 does not require a general permit for dry litter systems; instead, these systems are allowed to operate on a deemed permitted basis under state rule 15A NCAC 2T. However, animal operations with dry litter management systems serving 30,000 or more birds are required to develop animal waste management plans.

NPDES Permits
As discussed earlier, larger animal operations now have the option of being permitted under the NPDES General Permit or the State Nondischarge General Permit. The operations affected are those with 1,000 “animal units”.

The following numbers represent 1000 animal units for each species:
- 2500 swine - greater than 55 pounds
- 1000 cattle
- 700 mature dairy cows
- 30,000 poultry with a liquid waste system

Individual Permits
General permits (both state and NPDES) and “deemed permitted” status are intended for compliant facilities. Noncompliant facilities can be required by DEQ to obtain individual permits, which are types of permits issued to industries and municipalities.

Individual permits require extensive waste and site evaluations, engineering design of system components, detailed monitoring of operations with laboratory analyses of effluent, additional buffers for waste application, and regularly scheduled compliance visits by DWR. Operations with a history of compliance problems have additional monitoring and reporting requirements.

Permit Requirements
Although there are some differences, the State Nondischarge General Permit and the federal NPDES General Permit are similar. Some of the conditions common to both permits are discussed below. Many more will be covered as we move through this training. In the end, however, it is your responsibility as a certified operator to read and fully understand your permit in its entirety.

Performance Standards
- Discharge of Animal Waste

A discharge of animal waste means that animal waste leaves the waste management system. Discharges of animal waste are prohibited. This is one of the most fundamental concepts you must take away from this training. A discharge can result from runoff of waste after overapplication, as we learned from our discussion of the hydrologic cycle. But there are many other situations that can result in a discharge, including: land application to saturated, frozen, or snow-covered fields; catastrophic failure of a lagoon or other storage structure; and breaks in pipes or other failures of distribution components.

Explain what a waste system permit is and describe its general conditions.

Define “discharge” of animal waste.
All components of the animal waste management system must be designed, constructed, and operated as a nondischarge system to prevent the discharge of pollutants to streams and ditches. The only exception is a discharge resulting from a storm equal to or greater in intensity than a 25-year, 24-hour storm. To be classified as a 25-year, 24-hour storm, a storm must deliver from 5 to 9 inches of rain (depending on the region of the state) in one 24-hour period (Figure 2-1).

An unintentional discharge resulting from the 25-year, 24-hour storm is not a violation, if the operation is in compliance with its permit. However, don’t count on using rainfall as a defense for a discharge. A long rainy spell that lasts 3 to 4 days and delivers 10 inches of rain is not a 25-year, 24-hour storm.

- **Water Quality Standards**

The Division of Water Resources maintains water quality standards for many pollutants, including oxygen levels, bacteria, pH, nitrogen, phosphorus, and a variety of metals and chemicals. It is against the law for anyone to cause a water quality standard violation. For example, if waste from an animal operation lowers the dissolved oxygen level in a stream below the standard, then the owner is subject to civil/criminal penalties.

There are water quality standards for groundwater as well as for surface waters. The Groundwater Quality Standards are contained in 15A NCAC 2L. Animal waste permits require compliance with the 2L regulations that state that groundwater quality standards may not be exceeded at or beyond the Groundwater Compliance Boundary. The Compliance Boundary is a boundary established at either 250 feet from the waste disposal area or 50 feet within the property boundary, whichever is closest to the
waste disposal area. Exceedance of Groundwater Quality Standards at or beyond the Compliance Boundary is subject to immediate corrective action in addition to the penalty provisions applicable under the North Carolina General Statutes.

**Certified Animal Waste Management Plans**

An animal waste management plan that is approved or “certified” by a technical specialist is required for all permitted animal operations. Although it is actually a separate document, the Certified Animal Waste Management Plan (CAWMP) is incorporated by reference into the permit. A violation of the standards and conditions in the CAWMP is a violation of the permit.

The CAWMP contains most of the design information specific to each operation and establishes individual nutrient management requirements. It is considered the backbone of the permit because it provides the operator with a roadmap for operating a particular system. It is so important that all of Chapter 3 is devoted to it.

All major changes and revisions to the CAWMP, along with an explanation identifying all major changes and revisions, must be submitted to the appropriate DWR regional office within 30 calendar days after the major changes or revisions occur.

**Operation and Maintenance Requirements**

- **Excessive Ponding and Runoff**

  Land application rates cannot result in excessive ponding (defined in the permit as “any area of the application field where visible liquid waste is ponded on the surface of the land application site more than four hours following the application of waste”) or any runoff during any given application event.

- **Certified Operator Requirements**

  Owners must designate a certified animal waste management system operator to be the Operator in Charge (OIC) of the animal waste management system (see Operator in Charge Designation Form in Appendix B). The system must be operated by the OIC or a person under the OIC’s supervision. During the application of waste, the site must be inspected and documented at least every 120 minutes.

- **Soil Testing and Crop Management**

  Regular soil testing is integral to proper operation of an animal waste management system. It allows farm owners/managers to monitor the nutrient status and productive capability of soils in land application fields. Some heavy metals can accumulate in the soil over time to a point where they negatively impact plant growth. If a soil test report shows either the copper or zinc index exceeds 3,000, land application must stop on those fields. Crops from all fields in the certified waste plan must be harvested and properly utilized. Harvestable crops cannot be allowed to become unusable due to prolonged exposure to weather.
Monitoring and Reporting Requirements

- **System Inspections**
  Inspections of all components of the waste management system must be conducted and documented at a frequency to ensure proper operation but at least monthly and after all storm events of greater than one inch in 24 hours.

- **Equipment Calibration**
  All waste application equipment, including irrigation systems, hose drag systems, honey wagons, and solid spreaders, must be field tested and calibrated to verify operating performance and application amount. Field calibration to verify application amount is required once a year for NPDES permitted operations and once every other year for state permitted operations. For irrigation systems, the minimum calibration performance requirements that must be verified within specific parameters are operating pressure at the sprinkler/gun, wetted diameter, and flow rate. If these three items are within specified ranges, application uniformity is deemed acceptable. For hose drag systems, the tractor speed, flow rate, and effective application width are used to determine application depth. For liquids and solids applied with a manure spreader, the spreader capacity and spread area are used to determine the application rate.

- **Freeboard Levels**
  Lagoon freeboard levels must be recorded weekly. If lagoon freeboard violations occur in two consecutive years, owners may be required to install automated lagoon level monitors.

- **Precipitation Events**
  A rain gauge must be installed at the farm to measure all precipitation events and the precipitation type and amount must be recorded on forms supplied by or approved by DWR.

- **Sludge Surveys**
  Sludge accumulation must be measured annually in lagoons and storage ponds that are not routinely agitated and pumped out. This survey frequency may be reduced if it can be demonstrated to the satisfaction of DWR that the rate of sludge accumulation does not warrant an annual survey. The sludge survey must include a map of the lagoon with the respective measured sludge depths and a calculation of the available treatment capacity depth in the lagoon.

  If the sludge accumulation is such that the structure does not satisfy the criteria set by NRCS North Carolina Conservation Practice Standard 359, a Plan of Action (POA) for Lagoon Sludge Reduction or a certified Sludge Management Plan must be submitted to the appropriate DWR regional office within 90 days of the determination. The plan must describe removal and waste utilization procedures to be used. Compliance regarding sludge levels must be achieved within two years of the determination.
• **Mandatory Reporting**

If there is a discharge to surface waters or wetlands, the owner is responsible for ensuring that the discharge is reported and the required information is submitted to DWR.

The appropriate DWR regional office must be notified by the owner no more than 24 hours after the occurrence of any of the following:

- Waste discharges
- Failure to maintain required freeboard in a lagoon or storage pond
- Overapplication of waste
- Failure of any component of the animal waste system which results in a discharge or renders the system incapable of treating or storing the waste
- All waste spills from waste transporting equipment
- Deterioration or leak in lagoons or storage ponds

• **Record Keeping**

All records required by the permit and a facility’s CAWMP must be maintained by the owner in chronological and legible form. Operations with a State Nondischarge General permit are required to maintain these records for a minimum of three years. Operations with a NPDES Nondischarge General permit are required to maintain these records for a minimum of five years. These records include but are not limited to soil and waste analysis, rain gauge readings, freeboard levels, irrigation and land application event(s), past inspection reports and operational reviews, animal stocking records, records of additional nutrient sources applied (including but not limited to sludges, unused feedstuff leachate, milk waste, septage and commercial fertilizer), cropping information, crop yields, waste application equipment testing and calibration, and records of transfer of separated solids to off-site location(s).

**Inspections and Entry**

Except for those located in one of four “pilot” counties, animal operations are now visited one time a year by DWR staff for:

- Violations of water quality standards
- Animal waste management plan compliance
- Compliance with all other permit conditions

DWR may conduct additional inspections as needed to follow up on corrective actions or to investigate complaints.

Animal operations in the pilot counties (Columbus, Jones, Brunswick, and Pender) are visited one time a year by the Division of Soil and Water Conservation (DSWC) instead of by DWR. DSWC immediately reports any permit violations to DWR for further investigation and enforcement actions as warranted.
Division of Soil and Water Conservation staff also conduct operation reviews for any animal operation upon request. These voluntary reviews may include review of operation records, waste storage structures and waste application equipment.

**General Conditions**

Permits are issued for five years. However, DWR may reopen and modify, revoke, reissue, or terminate a permit at any time, under its authority from the Clean Water Act and state law.

Owners are required to pay an annual fee. Failure to pay the appropriate annual fee may result in revocation of the permit.

**Penalties**

Owners must comply with all conditions of their permits. Any permit noncompliance is a violation of state and possibly federal law.

- **Notices of Deficiency**
  
  A Notice of Deficiency (NOD) is a letter that DWR sends to an owner when minor violations are found at a facility. A NOD is appropriate when the violations are of minor duration and gravity, resulting in little or no harm to the environment or public health.

- **Notices of Violation**
  
  A Notice of Violation (NOV) is a letter that DWR sends to an owner giving notice of noncompliance with the permit and with environmental law(s). The letter is designed to notify the owner of the specific violation and associated law or regulation. In addition, the NOV describes what the owner is required to do to correct the violation or what the owner must do as a result of the violation. Generally, the NOV indicates that the owner must complete the corrective actions and notify the DWR within a certain period of time. It is very important that the owner respond to DEQ in writing if issued an NOV and that they follow through completely with corrective actions specified in the NOV.

- **Civil Penalties**
  
  An NOV is often the first step in an enforcement action that may result in a civil penalty. Civil penalties are fines assessed against an owner by the Director of DWR. General Statute 143-215.6A allows for the assessment of civil penalties of up to $25,000 per day per violation. Each day that a violation occurs may be considered as a separate violation.

- **Changes in Permit Status**
  
  Major violations or continued acts of noncompliance may result in the loss of “deemed permitted” status or coverage under a general permit, requiring the operation to obtain an individual permit. A facility with a state general or individual permit may be required to obtain a NPDES permit as a result of certain violations. Permits may be terminated and coverage under any type of permit denied.
• **Injunctions**

If an owner demonstrates consistent non-compliance with regulations or if there is an imminent danger to health or the environment, a county health director can issue an injunction, or court order, to discontinue or prevent an existing or potential violation. In the worst case scenario, this could result in the removal of animals and closure of the operation.

• **Criminal Penalties**

Owners who willfully, knowingly, or negligently violate their permits are subject to criminal penalties, even imprisonment. State and/or Federal authorities may be involved in investigating a facility. Violations may be deemed negligent if they repeatedly occur because an owner fails to take the necessary action to correct the problem.

An example of a willful and knowing violation is the existence of a man-made “conveyance” for discharging animal waste. A conveyance is a pipe, ditch, or other structure that can be used to transport waste away from an animal operation or to discharge wastes from a holding pit or lagoon.

The *presence* of such a structure constitutes a violation, regardless of whether there is an actual discharge of waste. However, it is important to understand that man-made conveyances are different from engineered spillways considered in new designs for waste storage ponds and lagoons. Engineered spillways are not conveyances in this context.

**Operator Certification Program**

Senate Bill 1217 requires a certified operator for all animal operations with liquid waste management systems that serve the following number of animals:

- 250 or more swine;
- 100 or more confined cattle;
- 75 or more horses;
- 1,000 or more sheep; or
- 30,000 or more confined poultry.

As required by North Carolina General Statute 90A-47.2, owners of animal operations with animal waste management systems must designate an **Operator in Charge** (OIC) for each of their systems. An OIC is a person who holds a currently valid certificate to operate an animal waste management system and who has primary responsibility for the operation of the system.

The goal is to ensure that animal waste is handled properly in an environmentally sound manner, without negative impacts on state surface waters, groundwater, soils and crops, grazing animals or other consumers of the crops, and without impacts to neighbors.
To help meet this goal, two training and certification programs have been developed. If you intend to operate a swine or a poultry operation with a liquid waste management system, you must obtain a Type A certificate. If you intend to operate an animal waste management system involving cattle, horses, goats, or sheep, you must obtain a Type B certificate.

Only the OIC, or someone under his or her direct supervision, may apply animal waste to land. The owner or other person in control of the land is responsible for making sure that the land application is performed by an OIC or a person under the direct supervision of the OIC. Fines may be imposed if waste is land applied without a certified operator.

**Water Pollution Control System Operators Certification Commission**

The regulatory body responsible for the certification of animal waste management system operators is the Water Pollution Control System Operators Certification Commission (WPCSOCC). The WPCSOCC is also responsible for the certification of other water pollution control system operators, such as wastewater treatment plant operators, collection system operators, spray irrigation system operators, land application of residuals system operators, and subsurface system operators.

In addition to certification of operators, the WPCSOCC is responsible for the classification of water pollution control systems and the development and implementation of training programs for the certification of operators.

The WPCSOCC has 11 members. Two members represent the animal agriculture industry and are appointed by the Commissioner of Agriculture. The remaining nine members are appointed by the Secretary of DEQ and represent other areas of the water pollution control system industry. The WPCSOCC is assisted by the staff of DWR’s Operator Certification Unit.

**Classification of Animal Waste Management Systems**

The WPCSOCC has established two types of animal waste management systems: Type A Animal Waste Management Systems and Type B Animal Waste Management Systems.

Type A systems primarily rely on an anaerobic lagoon and soil/plant systems for the treatment of animal waste. These systems are generally used to treat animal waste generated by animals that produce a **low-fiber waste, such as swine and poultry**. These systems generally include the following components: anaerobic lagoon; pumps, pipes and other structures that carry waste from the point of generation to the final treatment/disposal site; flushing systems; solids separation equipment; irrigation equipment; and land application site and crops.

Type B systems primarily rely on soil/plant systems for the treatment of animal waste. These systems are generally used to treat animal waste generated by animals that produce a **high-fiber waste, such as cattle, horses, goats, and sheep**. These systems generally include the following components: dry stacks; solids and slurry collection...
equipment; waste storage ponds for the collection of solids and runoff; pumps, pipes and other structures that carry waste from the point of generation to the final treatment/disposal site; flushing systems; solids separation equipment; irrigation equipment; and land application site and crops.

Upon classification, owners of animal waste management systems must designate an OIC by submitting a properly completed OIC Designation Form (Appendix A) to the WPCSOCC. Designation of one backup OIC is optional.

Owners of new animal operations having animal waste management systems must designate an OIC before these systems are placed into operation. Owners of existing animal operations must designate a new OIC within 30 days of a vacancy in the OIC position. Failure to designate an OIC may result in the assessment of civil penalties.

Certification of Operators

Separate training and certification programs have been developed for each type of animal waste management system. To become certified as a Type A or Type B Animal Waste Management System Operator, you must complete the appropriate training program and pass the appropriate examination.

Responsibilities of Certified Operators

To maintain your certification, you must pay an annual renewal fee and complete 6 hours of additional training every three years. If you fail to pay the annual renewal fee within 30 days of the due date or if you fail to complete the approved additional training within 30 days of the end of the three-year period, you must take and pass another examination in order to become certified again.

All certified operators, regardless of whether or not you are a designated OIC of an animal waste management system, must notify the WPCSOCC within 30 days, in writing, of a change in address.

Responsibilities of an Operator in Charge or Backup OIC

As the designated OIC or back-up OIC of any type of animal waste management system, you must:

- possess a currently valid animal waste management system operators certificate of the appropriate type;
- visit and inspect each animal waste management system at a frequency to ensure proper operation of the system;
- inspect, or have a person under your supervision inspect, the land application site as required in the permit;
- ensure that animal waste is being applied in accordance with the animal waste management plan and the permit;
- properly manage, supervise, and document daily operation and maintenance of the system;
- certify monitoring and reporting information as required in the permit; and
- be available for consultation, emergencies, and inspections.

Describe the necessary steps required to renew your animal waste management system operator certification.

Describe the duties and requirements of an Operator in Charge of an animal waste management system.
In addition, the OIC or the designated back-up OIC of a Type A system must:

- inspect the waste application system as required by the permit, and inspect the land application site within 24 hours of the application of animal waste if the OIC was not present during the application of animal waste.

The OIC or the designated back-up OIC of a Type B system must:

- inspect the waste application system as required by the permit, and inspect the land application site within 48 hours of the application of animal waste if the OIC was not present during the application of animal waste.

Responsibilities of Contract Operators

Contract Operators (certified operators that contract with owners of animal waste management systems to serve as an OIC) are required to submit an annual report to the WPCSOCC by January 15 of each year.

The annual report (Appendix A) must include the name of the certified operator, mailing address, phone number, and certificate number. It must also include the name, mailing address, county, facility identification number, and type of each animal waste management system for which the certified operator has been designated as OIC.

Disciplinary Actions

Under certain circumstances, the WPCSOCC may take disciplinary actions against a certified operator. The WPCSOCC may:

- Issue the operator a letter of reprimand
- Suspend an operator’s certificate
- Revoke an operator’s certificate

The WPCSOCC may take these actions if it finds that an operator:

- Has practiced fraud or deceit
- Has not exercised reasonable care, judgment, or the use of knowledge and ability in the performance of their duties
- Is incompetent or unable to perform required duties

Other Regulations

In addition to the state and federal laws and regulations discussed above, there may be local regulations that apply to animal operations. Generally, local regulations deal with the zoning or location of animal operations as opposed to the actual operation of the facility.

However, in 1991 the N.C. General Assembly explicitly defined bona fide farms to include the production of livestock and poultry. These as defined are exempted from county zoning ordinances, but not from city or town ordinances.

It is beyond the scope of this manual to review pertinent local regulations and the legal issues surrounding them. The owner and operator of an animal operation should research the pertinent local regulations to make sure they are in compliance with these, if any.
Information on such regulations should be available from the county planning and zoning office, the county manager’s office, or the county health department.

**Review Questions**

1. What does an animal waste permit consist of?

2. What agency issues animal waste permits?

3. Define OIC and list the responsibilities of an OIC.

4. How does a certified operator renew their license?
Chapter 3: Components of a Certified Animal Waste Management Plan

Current regulations require certified animal waste management plans for all facilities meeting the criteria of an animal operation and subject to either state or NPDES permits. Subject facilities include animal operations with 250 or more swine, 100 or more confined cattle, 75 or more horses, 1,000 or more sheep, and 30,000 or more confined poultry that use a liquid waste management system. The animal waste management plan describes the entire waste management system, including animal types and numbers, the amount of waste generated, manure treatment and/or storage structures, associated engineering designs, site and field maps, the fields and associated crops receiving the waste, applicable setbacks, operation and maintenance practices, and the best management practices (BMPs) and conservation practices specific to the operation.

A Certified Animal Waste Management Plan (CAWMP) contains these components:

1. **General information**—This includes the farm address, location, type of facility, name of owner, name of waste system operator, the state or NPDES general permit, certificate of coverage, and signed animal waste management plan certification form.

2. **Design and site evaluation**—This includes all details related to the siting and design of the animal operation. It includes site, soil, wetlands, and floodplain evaluations, dam hazard classification, lagoon or other waste storage/treatment structure design and construction specifications, other waste management system components, and an operations and maintenance plan.

3. **Waste utilization plan (WUP)**—This includes all details related to the management of the waste collection, storage, handling, and land application system. It includes the volume of waste generated, all fields and receiving crops available for waste application, waste application timing, and hydraulic restrictions. It also includes any plan amendments and revisions and a list of management conditions, often referred to as the “required specifications.”

   **NOTE:** This chapter will focus mainly on the waste utilization plan component of the waste management plan, as this contains the day-to-day issues affecting decisions and management of the waste handling system.

4. **Irrigation design**—This component includes the irrigation system layout, operating parameters, and related equipment and hardware to properly apply waste at agronomic rates on receiving crops. The design includes site maps and the system’s calculations/specifications determining the total amount of effectively irrigated, or “wettable” acreage on an animal operation. If a wettable acreage determination is required, the related certification and documentation is considered part of the waste management plan.

5. **Other CAWMP components**—These include the emergency action plan, odor checklist, insect control checklist, mortality checklist, sludge surveys, NPDES annual
certifications if applicable, and the necessary application records, soil samples, and waste analyses associated with these activities.

Waste Utilization Plans

The primary goal of a waste utilization plan is to prevent accumulation of nutrients (such as nitrogen, phosphorus, potassium, calcium, magnesium, zinc, and copper) on your farm to the point where they threaten plant growth or the environment. Nutrients come to your farm as animal feeds and mineral additives. Animals transform these nutrients into body tissue, products (milk, eggs, etc.), and wastes. Unless these waste nutrients are transported off the farm, they will build up to levels that could harm soil fertility, crops, groundwater, and surface water. A land application system on the farm allows waste nutrients to be used to grow crops. The nutrients in the form of crops can then be exported from the farm to prevent nutrient buildup or recycled back to the animals as feed.

A WUP begins as a tool to help you define the number of acres and types of crops to be grown based on the volume of waste produced and the nutrient requirements of your crops. The process requires estimating the volume of animal waste produced and the amount of plant-available nutrients contained in the waste. Based on these factors, environmentally sound cropping systems are matched with your waste-handling systems to develop acceptable methods for land application.

Once waste is generated on your farm, the plan must be implemented. A WUP requires proper management for successful use of the nutrients produced. A properly implemented plan will let you use the waste nutrients as a fertilizer while ensuring that water quality on and off your farm is protected. You will need to understand how to use the information in your plan, how to monitor the information and record results, and how to calibrate the equipment to make the plan work.

Current WUPs use nitrogen (N) as the priority nutrient. An estimation of the amount of N produced annually at any animal operation is used as the target for determining the number of acres needed to handle the N as fertilizer for the crops to be grown. All plans must show a “nitrogen budget deficit,” meaning that sufficient or excess land is available to handle the expected N produced by the animals. In special situations, and at larger animal operations, a periodic phosphorus (P) assessment must be done to determine if phosphorus should be the priority nutrient for certain fields.

When discussing nitrogen, one must be familiar with the distinction between total N and plant available nitrogen, abbreviated PAN. Since not all manure N is available to crops, estimates of availability are used when developing a plan to determine what percentage of total N is PAN. This will be discussed in more detail later in this chapter.

Waste utilization plan development is directed by the animal producer and is completed by a technical specialist. A technical specialist is an individual trained in waste utilization and nutrient management and is designated by the North Carolina Soil and Agriculture Service.
Chapter 3: Components of a Certified Animal Waste Management Plan

Water Conservation Commission to write CAWMPs and WUPs. A copy of the signed and dated plan is maintained at the farm, and copies are filed with the local Soil and Water Conservation District Office and the Division of Water Resources Regional Office.

The waste utilization plan contains the following components:

1. Waste generation rate for all animal types
2. Amount of PAN produced annually
3. Farm maps with soil types and acreage
4. Selection of crops and rotations for each field
5. Determination of N utilization for these crops
6. Tables showing N utilization by crops, waste application windows, and total N budget for the cropping system
7. Irrigation application factors
8. Required specifications
9. WUP Agreement
10. Leased land or contractor agreements, if any

At the end of this chapter is an example of a waste utilization plan. Your instructor will refer to this plan and point out important sections that you need to be familiar with.

**Waste Generation Rate**

The amount of manure produced at an animal operation can be estimated by using Table 3-1. The annual waste generation rate times the number of animals gives the total yearly volume of waste to be handled.

**Amount of PAN Produced Annually**

The average total content of nitrogen (N), phosphorus (P2O5), and potassium (K2O) found in several types of animal waste is shown in Table 3-2. These statewide average values are used for planning new facilities in North Carolina. The nutrient content of animal waste can vary widely, depending on animal diet, type of production facility, type of treatment and/or storage, time of year, and recent rainfall.
<table>
<thead>
<tr>
<th>Animal Production System</th>
<th>NCDA&amp;CS Waste Code</th>
<th>Accumulated Manure gallons per animal/year*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaerobic Lagoon Liquid – Swine</td>
<td>ALS</td>
<td></td>
</tr>
<tr>
<td>Farrow-to-Wean (per sow)</td>
<td></td>
<td>3,203</td>
</tr>
<tr>
<td>Farrow-to-Feeder (per sow)</td>
<td></td>
<td>3,861</td>
</tr>
<tr>
<td>Farrow-to-Finish (per sow)</td>
<td></td>
<td>10,478</td>
</tr>
<tr>
<td>Wean-to-Feeder (per pig)</td>
<td></td>
<td>191</td>
</tr>
<tr>
<td>Wean-to-Finish (per pig)</td>
<td></td>
<td>776</td>
</tr>
<tr>
<td>Feeder-to-Finish (per pig)</td>
<td></td>
<td>927</td>
</tr>
<tr>
<td>Anaerobic Lagoon Sludge – Swine</td>
<td>ASS</td>
<td></td>
</tr>
<tr>
<td>Farrow-to-Wean (per sow)</td>
<td></td>
<td>78</td>
</tr>
<tr>
<td>Farrow-to-Feeder (per sow)</td>
<td></td>
<td>94</td>
</tr>
<tr>
<td>Farrow-to-Finish (per sow)</td>
<td></td>
<td>382</td>
</tr>
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<td>Wean-to-Feeder (per pig)</td>
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<td>6.7</td>
</tr>
<tr>
<td>Wean-to-Finish (per pig)</td>
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<td>Feeder-to-Finish (per pig)</td>
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<td>33</td>
</tr>
<tr>
<td>Dairy – Slurry</td>
<td>LSD</td>
<td></td>
</tr>
<tr>
<td>Calf</td>
<td></td>
<td>1,876</td>
</tr>
<tr>
<td>Heifer</td>
<td></td>
<td>5,535</td>
</tr>
<tr>
<td>Milk Cow</td>
<td></td>
<td>7,749</td>
</tr>
<tr>
<td>Anaerobic Lagoon Liquid – Poultry</td>
<td>ALP</td>
<td>1,659</td>
</tr>
<tr>
<td>Pullet (non-laying)</td>
<td></td>
<td>9,110</td>
</tr>
<tr>
<td>Pullet (laying)</td>
<td></td>
<td>22,201</td>
</tr>
<tr>
<td>Layer</td>
<td></td>
<td>25,373</td>
</tr>
<tr>
<td>Anaerobic Lagoon Sludge – Poultry</td>
<td>ASP</td>
<td>1,659</td>
</tr>
<tr>
<td>Pullet (non-laying)</td>
<td></td>
<td>4,147</td>
</tr>
<tr>
<td>Pullet (laying)</td>
<td></td>
<td>4,147</td>
</tr>
<tr>
<td>Layer</td>
<td></td>
<td>4,739</td>
</tr>
<tr>
<td>Dairy – Scraped</td>
<td>SSD</td>
<td></td>
</tr>
<tr>
<td>Calf</td>
<td></td>
<td>4.1</td>
</tr>
<tr>
<td>Heifer</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Milk Cow</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>Beef – Scraped</td>
<td>SSB</td>
<td></td>
</tr>
<tr>
<td>Stocker</td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>Feeder</td>
<td></td>
<td>2.2</td>
</tr>
<tr>
<td>Brood Cow</td>
<td></td>
<td>3.0</td>
</tr>
<tr>
<td>Horse – Scraped</td>
<td>SSH</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9.1</td>
</tr>
</tbody>
</table>

* To convert gallons to acre-inches, divide gallons by 27,154
**Table 3-2. Estimated Nutrient Composition of Animal Manure for Developing Plans for New Operations**

Total nitrogen (N), phosphorus (P) and potassium (K) from manure nutrient sources.

<table>
<thead>
<tr>
<th>Production System</th>
<th>NCDA&amp;CS Waste Code</th>
<th>N</th>
<th>P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;</th>
<th>K&lt;sub&gt;2&lt;/sub&gt;O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaerobic Lagoon Liquid – Swine</td>
<td>ALS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boar</td>
<td></td>
<td>3.6</td>
<td>1.4</td>
<td>8.3</td>
</tr>
<tr>
<td>Farrow-to-Wean</td>
<td></td>
<td>2.4</td>
<td>0.9</td>
<td>4.1</td>
</tr>
<tr>
<td>Farrow-to-Feeder</td>
<td></td>
<td>3.6</td>
<td>1.4</td>
<td>8.3</td>
</tr>
<tr>
<td>Farrow-to-Finish</td>
<td></td>
<td>3.6</td>
<td>1.4</td>
<td>8.3</td>
</tr>
<tr>
<td>Wean-to-Feeder</td>
<td></td>
<td>3.6</td>
<td>1.4</td>
<td>8.3</td>
</tr>
<tr>
<td>Wean-to-Finish</td>
<td></td>
<td>3.6</td>
<td>1.4</td>
<td>8.3</td>
</tr>
<tr>
<td>Feeder-to-Finish</td>
<td></td>
<td>3.6</td>
<td>1.4</td>
<td>8.3</td>
</tr>
<tr>
<td>Anaerobic Lagoon Sludge – Swine</td>
<td>ASS</td>
<td>20.4</td>
<td>30.6</td>
<td>7.5</td>
</tr>
<tr>
<td>Anaerobic Lagoon Liquid – Poultry</td>
<td>ALP</td>
<td>3.1</td>
<td>1.0</td>
<td>13.8</td>
</tr>
<tr>
<td>Anaerobic Lagoon Sludge – Poultry</td>
<td>ASP</td>
<td>24.4</td>
<td>38.1</td>
<td>10.3</td>
</tr>
<tr>
<td>Dairy – Slurry</td>
<td>LSD</td>
<td>16.7</td>
<td>9.1</td>
<td>15.4</td>
</tr>
<tr>
<td>Dairy – Scraped</td>
<td>SSD</td>
<td>11.2</td>
<td>7.0</td>
<td>9.8</td>
</tr>
<tr>
<td>Horse – Scraped</td>
<td>SSH</td>
<td>9.3</td>
<td>7.0</td>
<td>9.8</td>
</tr>
<tr>
<td>Beef – Scraped</td>
<td>SSB</td>
<td>13.0</td>
<td>8.3</td>
<td>13.6</td>
</tr>
</tbody>
</table>

* To convert gallons to acre-inches, divide gallons by 27,154 (or 1,000 gallons by 27.154)

*Remember, the values in Table 3-2 are for planning purposes only.* Once a farm is operating, waste applications must be based on recent waste analysis results to avoid under- or overapplication of nutrients. Methods of sampling and how to use waste analysis reports will be described in Chapter 4.

In addition to calculating the amount of nutrients generated by the animal manure, you must consider all other sources of nutrients available to a growing crop. This includes starter fertilizers or other commercial sources. Soybeans and peanuts can leave 20 to 40 pounds of residual PAN in the soil for the following crop. Clover and alfalfa can supply 60 to 100 pounds of residual PAN. The waste utilization plan will specify the required amount of carryover N to be recorded for any crop that leaves residual PAN.

**Farm Maps**

Maps of the fields to be used for waste application are included in the plan. These maps depict soil types, slopes, layout of irrigation system, blue-line streams, ditches, property lines, field area available (acres), etc., for manure application. Soil types are important, as the crop yield that can be expected for a given crop is dependent on the soil type. As crop yield varies by soil type, so must your rate of manure application.
Crop Selection

To apply the waste nutrients in amounts that will not degrade water quality, you must determine the crops to be grown, the nutrient requirements of each crop, and when they are actively taking up nutrients. You will also need to understand the terms agronomic rate, priority nutrient, and realistic yield expectation.

The term agronomic rate is often used in reference to waste utilization. Agronomic rate means that nutrients will be applied in accordance with the nutrient needs of the crop. Nutrients applied in excess of crop needs may have a negative environmental impact. Thus, rates and timing of application must be made to optimize the uptake of nutrients. This can be fairly straightforward for planning.

Plants need 16 different nutrients in order to complete their lifecycle. Usually, only one of the many nutrients present in animal waste can be applied at a rate that meets the needs of a specific crop. If you have to choose one of the 16 essential elements to base application rates on, how do you decide which one? One way is to pick the nutrient present in highest amounts. Or, you could choose the one that is the most costly to purchase. From an environmental and crop production standpoint, however, it makes more sense to select the nutrient that is most likely to cause a problem either to the plant or to the environment when too much is applied. This nutrient is called the priority nutrient. For most animal waste utilization plans, nitrogen is the priority nutrient.

In order to determine the amount of waste to apply, the nutrient requirements of the crops to be planted must be known. Crops are an integral part of the treatment system. In a waste management system, the function of the crop is to:

- Use the applied nutrients for growth
- Prevent soil erosion
- Maintain a productive soil environment
- Take up water from liquid wastes
- Provide food and habitat for organisms in the soil that further break down and use the waste products

Crops for waste utilization are often selected for their ability to take up large amounts of nutrients. While this is very important, other factors should be considered. These include:

- Adaptation to the local climate, soil types, drainage systems, etc.
- Ability to use nutrients when waste applications must be made
- Ease of management
- Harvest requirements
- Marketability
- Profitability

Define agronomic rate.
Describe the priority nutrient concept.
Describe the role of vegetation in waste management.
List factors to consider in crop selection.
Crop Nutrient Requirements

Crops vary in their ability to use nutrients. Because the amount of nutrients required by a crop usually varies directly with the yield, there must be some way of estimating the yields expected on different soil types. Yields vary with weather conditions, soils, cultivars, pest pressure, level of management, and many other factors; therefore, the best way to estimate yield potential is to use existing production records. Where records are available, you can average the three highest yields in five consecutive crop years for the field.

Realistic yield expectation (R.Y.E.) is the estimated crop yield for a given field. Where records are not available, values of realistic yield expectations for agricultural soils have been determined by the Natural Resource Conservation Service (NRCS) in conjunction with North Carolina Cooperative Extension and other agencies. These values are based on inherent soil properties and data collected from various research projects. Realistic yield tables are used by the technical specialist to develop nutrient application rates for your crops. These tables can be found at: http://nutrients.soil.ncsu.edu/yields.

N Utilization

The technical specialist will use crop yield estimates based on the predominant soil type in each field along with Table 3-3 to estimate the total PAN needed per field per crop year. N rates are tied to the R.Y.E. database (crop and soil) that is maintained by NC State but is a product of the Interagency Nutrient Management Committee (www.ncmhtd.com/rye).

Each individual field will have a PAN limit that must not be exceeded or a violation of the plan and permit will result. Once all the fields and crops have been evaluated, the total rate of PAN usage is compared to the PAN generated for the facility. A PAN deficit is required, meaning the farm is able to use all of the manure nitrogen produced for crop production.

If you do not have enough land to handle the PAN produced, your options are:

- Obtain more acreage for manure application
- Change cropping types or patterns to use more N per acre
- Use a custom applicator or third party hauler to remove some waste from your farm
- Reduce the N in your wastewater by further treating the waste prior to application (see Chapter 5)
- Reduce number of animals proposed or already at the facility; or change type of animal production to produce less PAN (requires permit and certification change)
- Change animal feed rations to reduce total manure nutrient production
### Table 3-3. Nitrogen Fertilization Guidelines.

<table>
<thead>
<tr>
<th>Commodity</th>
<th>1b PAN/Realistic Yield Expectation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn (grain)</td>
<td>1.0 to 1.25 lb N/bu</td>
</tr>
<tr>
<td>Wheat (grain)</td>
<td>1.7 to 2.4 lb N/bu</td>
</tr>
<tr>
<td>Rye (grain)</td>
<td>1.7 to 2.4 lb N/bu</td>
</tr>
<tr>
<td>Oats (grain)</td>
<td>1.0 to 1.3 lb N/bu</td>
</tr>
<tr>
<td>Barley (grain)</td>
<td>1.4 to 1.6 lb N/bu</td>
</tr>
<tr>
<td>Soybean (grain)</td>
<td>3.5 to 4.0 lb N/bu</td>
</tr>
<tr>
<td>Triticale (grain)</td>
<td>1.4 to 1.6 lb N/bu</td>
</tr>
<tr>
<td>Sorghum (grain)</td>
<td>2.0 to 2.5 lb N/cwt</td>
</tr>
<tr>
<td>Corn (silage)</td>
<td>10 to 12 lb N/ton</td>
</tr>
<tr>
<td>Sorghum-sudangrass (hay 1)</td>
<td>45 to 55 lb N/dry ton</td>
</tr>
<tr>
<td>Pearl millet (hay 1)</td>
<td>45 to 55 lb N/dry ton</td>
</tr>
<tr>
<td>Bermudagrass (hay 1)</td>
<td>40 to 50 lb N/dry ton</td>
</tr>
<tr>
<td>Tall fescue (hay 1)</td>
<td>40 to 50 lb N/dry ton</td>
</tr>
<tr>
<td>Orchard grass (hay 1)</td>
<td>40 to 50 lb N/dry ton</td>
</tr>
<tr>
<td>Timothy (hay 1)</td>
<td>40 to 50 lb N/dry ton</td>
</tr>
<tr>
<td>Small grain (hay 1)</td>
<td>50 to 60 lb N/dry ton</td>
</tr>
<tr>
<td>Cotton</td>
<td>0.06 to 0.12 lb N/lb lint</td>
</tr>
<tr>
<td>Pine trees</td>
<td>40 to 60 lb N/acre/year</td>
</tr>
<tr>
<td>Hardwood trees</td>
<td>70 to 100 lb N/acre/year</td>
</tr>
</tbody>
</table>

1 Reduce N rate by 25 percent when grazing.

### Application Windows

Once the crops to be used for waste application are determined, some estimate of appropriate waste application times will be made. Plants will use the majority of required nutrients during certain times associated with stages of growth. The WUP will contain tables that show the acceptable manure application times for the crops used in the plan. These cropping windows are designed to optimize uptake of the manure nutrients while minimizing environmental impacts from nutrients not used by plants and potentially lost to the environment.

### Irrigation Application Factors

Different soils have differing abilities to absorb irrigated wastewaterr. The technical specialist will review the soil types and assign application factors to each field, based on NC State University and NRCS data. These factors are inches per hour (in/hr) application rate and total inches per application event. These will be used in the irrigation system design as well as operational decisions. These topics will be covered in detail in Chapter 6.
Required Specifications (Best Management Practices)

Best management practices (BMPs) are the structural or operational practices that help you operate a waste management system with minimal impacts to the environment. BMPs help reduce nutrient losses from the farm. BMPs include erosion and sediment control to reduce movement of topsoil and nutrients into streams. Injection of wastes to reduce runoff, volatile N losses, and odors is another available BMP.

BMPs, when properly carried out, can improve water and soil quality. Generally, an animal operation will have a combination of several BMPs. Key BMPs for animal waste management systems include:

- Critical area planting
- Stormwater diversion
- Stream fencing
- Windbreaks
- Buffer and filter strips; riparian areas
- Grassed waterway
- Calibrated irrigation system
- Soil, waste, and plant tissue sampling
- Water control structures and controlled drainage
- Water conservation practices in the animal buildings

The BMPs for your operation should be designed (and the installation reviewed) by an expert trained in these systems. It is beyond the scope of this manual to explain every BMP or combination that could be used. You should keep a maintenance schedule of your BMPs and refer to it frequently. The use of BMPs will provide water quality benefits only as long as the practices are designed, installed, and maintained properly. Many studies have been performed that document water quality improvement in streams adjacent to where BMPs have been used in surrounding agricultural areas. If BMPs are not performing their functions as designed, you should contact a technical specialist for advice on appropriate remedies.

Emergency Action Plan

A plan dealing with emergency situations is required as part of a farm’s CAWMP. Emergency action will be covered in detail in Chapter 9.

Odor Control

On many operations, odor is likely to be the number one concern from the general public, and it therefore becomes a major concern for the producer. Because people can detect a smell they find offensive, they assume there is an environmental problem. The good news is that odor can often be managed by reducing sources of odor. Decomposing manure is the most obvious source. Generally, decomposing manure that has undergone some type of anaerobic (without oxygen) breakdown has a more offensive odor than fresh manure.
Factors that affect odor include feed source, animal metabolism, and environmental conditions in which manure is stored and spread. Decomposing feed and carcasses can also contribute to odor.

The N.C. Division of Air Quality (DAQ) regulates air quality and addresses odor complaints. This division does not routinely inspect nor issue permits for air quality limits at animal operations. They will address and investigate complaints about odors and air quality. If a complaint is filed against your operation, an inspector will visit and make an assessment of the odor and nuisance potential. The findings of this visit may result in requirements for specific odor control measures to be installed. Appendix B has more information on the DAQ animal odor enforcement program (Section .1800 – Control of Odors).

Sound management is key for controlling farm odors. A checklist of best management practices for odor control is included in Appendix B of this manual. As part of your animal waste management plan, a technical specialist will help you select practices from this list to be used on your farm to control odors. Once the checklist is completed it becomes your responsibility to follow those practices.

**Insect Control**

Insect control can also be a community issue for both producers and the general public. Usually insect problems can be found where feed has spilled or manure has accumulated. Insect pests typically breed in moist, nutrient rich areas. Again, the good news is that insects can be controlled using best management practices.

A checklist of best management practices to control insects is included in Appendix B of this manual. As part of your animal waste management plan, a technical specialist will help you select practices from this list to be used on your farm. Once the checklist is completed it becomes your responsibility to follow those practices.

**Animal Mortality**

Animal mortality is regulated by the N.C. Department of Agriculture and Consumer Services (NCDA&CS) Veterinary Division. Your WUP will address the requirements of these regulations.

The management of animal mortalities is a critical component of a farm’s animal waste management system. Improper disposal of dead animals will increase the risk of spread of disease to livestock and humans, create odor issues, and can lead to degradation of ground and surface water quality. Proper and prompt mortality disposal is an essential component of an operations’ daily management responsibilities.

The following are acceptable animal mortality disposal methods:

- Burial three feet beneath the surface of the ground within 24 hours after knowledge of the death. The burial must be at least 300 feet from any flowing stream or public body of water and three feet above the water table.
- Rendering at a rendering plant licensed under G.S. 106-168.7
- Complete incineration.
In the case of dead poultry only, placing in a disposal pit of a size and design approved by the NCDA&CS.

- Mortality composting using a NCDA&CS or USDA-NRCS approved composting system design and process, which is permitted by the NCDA&CS Veterinary Division.

- Any method, including composting, which in the professional opinion of the State Veterinarian would make possible the salvage of part of a dead animal’s value without endangering human or animal health. Written approval of the State Veterinarian must be attached.

If there is a catastrophic natural disaster or a reportable disease event in North Carolina, the state veterinarian may issue specific mortality management guidelines for the event. Information will be communicated from the NCDA&CS Veterinary Division.

**WUP Agreement and Leased Land Agreements**

The waste utilization plan agreement must be signed by the animal producer and the technical specialist. This form is maintained on file by the local Soil and Water Conservation District, DWR, and on-site at the farm. If any land not owned by the producer is to be used in the waste management plan, a waste utilization agreement must be signed by each landowner involved and retained as a component of the WUP. An example agreement is found in Appendix B.

**WUP Changes**

When a waste utilization plan must be changed to accommodate changes at a farm or additions to the plan such as adding fields or changing crops, a technical specialist must make these changes on approved forms and under approved guidance. Some minor changes can be made easily, whereas major changes may require extensive technical review and redesign of some system components. The waste system owner is required to maintain a copy of the current waste utilization plan and all of its revisions or amendments at the farm. This document must be available to the waste system operator.

Changes to WUPs must follow all laws, regulations, and guidance in effect at the time of the change. For this reason and because laws change over time, some requirements for components of the waste plan may vary depending on the time the waste plan, revision, or amendment was made. For example, it is possible for there to be several different setbacks from waste application areas to surface waters depending on the dates the fields were added to the plan.

If the sludge survey (as required by state and NPDES permits) shows that the lagoon is in need of sludge removal, the waste plan must include a Plan of Action (POA) for Lagoon Sludge Reduction as required by DWR. The POA for Lagoon Sludge Reduction describes the method (e.g., microbes, sludge removal) to be used to lower the average sludge depth to a compliant level within two years of the survey date indicating non-compliance.

The Certified Sludge Management Plan is the farm’s specific sludge removal plan. The Plan must be certified by a designated technical specialist, and include the volume of sludge to be removed, the cropping system and fields that will be receiving the sludge, the removal
and application methods, the application windows, sludge analyses and other related records. Consideration must also be given to the potential for heavy metal build-up (copper and zinc) in soils due to the sludge application. A Certified Sludge Management Plan may be substituted for a Sludge Reduction POA to meet DWR’s monitoring and reporting requirements.

**Note:** A Plan of Action (POA) for Lagoon Sludge Reduction and a Certified Sludge Management Plan are separate and distinct. While a Certified Sludge Management Plan may be substituted for a Sludge Reduction POA, the reverse is not true: a Sludge Reduction POA cannot be substituted for a Certified Sludge Management Plan.

It is highly recommended that sludge be applied only to fields that are not used for continual animal waste application to prevent phosphorus and persistent metal build-up that may render sites unsuitable for long-term waste application. If the sludge is to be applied on sprayfields already listed in the CAWMP, the operation’s overall PAN balance must include the additional PAN from the sludge and still remain in a PAN deficit for the animal operation.

Some waste plans were written with sludge removal guidance, but many were not. Once a certified sludge management plan has been written, it becomes part of the waste utilization plan to show land application of the sludge based on agronomic rates. The operator must obtain a waste analysis of the sludge to complete all sludge application records.

Waste plan modifications should be done with existing farm records. Records of crop yields, soil tests, and waste analyses are all valuable tools for the technical specialist to use to revise a waste plan. Waste plan amendments, major changes, and revisions all have specific definitions that can be found in the General Permit (Appendix A).

**Phosphorus Loss Assessment Tool (PLAT)**

Facilities that hold an NPDES permit are required to obtain a PLAT assessment of all fields listed in the WUP. Other facilities may be required to obtain a PLAT assessment.

This tool assesses the potential for phosphorus (P) transport off-site by evaluating site-specific factors that address each of the four potential P loss pathways: particulate P attached to eroding soil particles, soluble P in surface storm runoff, leached soluble P moving down through the soil profile, and other P losses that could occur directly from the applied manure sources.

PLAT assessments must be performed by technical specialists trained in use of the software tool. Assessments are based on field conditions elements of the WUP and information provided by the producer, including current soil sampling reports, deep soil sampling reports (where applicable), cropping histories and waste application records. The PLAT assessment will result in a rating of low, medium, high, or very high. A low or medium
rating means that a field may still receive manure applications based on nitrogen agronomic rates. A high rating means that manure and other nutrient sources may be applied at a rate that cannot exceed the P removal rate of the crop or rotation. This rate will be substantially lower than current manure application rates based on N. A rating of very high will allow no additional P applications, and the field must be removed from the waste utilization plan portion of the CAWMP.

The PLAT tool is a working tool in that it not only assesses a field based on its current practices, but it looks at the “what if” possibilities to see if field management is changed, what effect might it have on a PLAT rating. If necessary, you can work with your technical specialist to examine alternatives. Conservation measures and deep tillage are mechanisms that could lower a PLAT rating and allow the continuance of a N-based manure application rate. The producer should be aware, however, that if one applies manure each year based on the crop N needs, soil P levels and the PLAT rating will likely increase over time.

Example Waste Utilization Plans
Following is an example of a waste utilization plan. The topics referenced in the previous text are highlighted here to help with your understanding of the waste utilization plan. You should become very familiar with your farm’s waste utilization plan, as it contains much information that you need in order to operate your waste system properly and in compliance with state law.

Review Questions

1. What is the goal of a waste utilization plan?

2. Where is a waste management plan required to be maintained?

3. How can you find how much PAN your fields are allowed to accept?

4. What is “realistic yield expectation?”

5. How are manure generation rates and PAN determined?

6. What are BMPs?

7. What agency issues permits for animal waste management?

8. Define “technical specialist.”
Nutrient Management Plan For Animal Waste Utilization
12-09-2016

This plan has been prepared for:

Sycamore Farm
Mary G Farmer
123 Sycamore Farm Lane
Anytown, NC 23456
1234567890

This plan has been developed by:

Eve H. Honeycutt
N C Cooperative Extension
Lenoir County Center
1791 Hwy 11/35
Kinston, NC 28504
252-527-2191

Type of Plan: Nitrogen Only with Manure Only

Owner/Manager/Producer Agreement
I (we) understand and agree to the specifications and the operation and maintenance procedures established in this nutrient management plan which includes an animal waste utilization plan for the farm named above. I have read and understand the Required Specifications concerning animal waste management that are included with this plan.

_________________________  _______________________
Signature (owner)           Date

_________________________  _______________________
Signature (manager or producer) Date

This plan meets the minimum standards and specifications of the U.S. Department of Agriculture - Natural Resources Conservation Service or the standard of practices adopted by the Soil and Water Conservation Commission.

Plan Approved By: _________________________
Technical Specialist Signature

_________________________  _______________________
Date  12-9-16

841436 Database Version 4.1 Date Printed: 12-09-2016 Cover Page 1
Nutrients applied in accordance with this plan will be supplied from the following source(s):

Commercial Fertilizer is not included in this plan.

<table>
<thead>
<tr>
<th>S75</th>
<th>Swine Wean-Finish Lagoon Liquid waste generated 2,824,640 gals/year by a 3,640 animal Swine Wean-Finish Lagoon Liquid operation. This production facility has waste storage capacities of approximately 180 days.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Estimated Pounds of Plant Available Nitrogen Generated per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadcast</td>
<td>5091</td>
</tr>
<tr>
<td>Incorporated</td>
<td>6110</td>
</tr>
<tr>
<td>Injected</td>
<td>6110</td>
</tr>
<tr>
<td>Irrigated</td>
<td>5091</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Max. Avail. PAN (lbs) * Actual PAN Applied (lbs) PAN Surplus/ Deficit (lbs) Actual Volume Applied (Gallons) Volume Surplus/ Deficit (Gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>5,091</td>
</tr>
<tr>
<td>Year 2</td>
<td>5,091</td>
</tr>
</tbody>
</table>

Note: In source ID, S means standard source, U means user defined source.

* Max. Available PAN is calculated on the basis of the actual application method(s) identified in the plan for this source.
The table shown below provides a summary of the crops or rotations included in this plan for each field. Realistic Yield estimates are also provided for each crop in the plan. In addition, the Leaching Index for each field is shown, where available.

### Planned Crops Summary

<table>
<thead>
<tr>
<th>Tract</th>
<th>Field</th>
<th>Total Acres</th>
<th>Usable Acres</th>
<th>Leaching Index (LI)</th>
<th>Soil Series</th>
<th>Crop Sequence</th>
<th>RYE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1234</td>
<td>1</td>
<td>10.50</td>
<td>9.50</td>
<td>N/A</td>
<td>Norfolk</td>
<td>Small Grain Overseed</td>
<td>1.0 Tons</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hybrid Bermudagrass Hay</td>
<td>6.5 Tons</td>
<td></td>
</tr>
<tr>
<td>1234</td>
<td>2</td>
<td>12.40</td>
<td>10.10</td>
<td>N/A</td>
<td>Goldsboro</td>
<td>Corn, Grain</td>
<td>130 bu.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Wheat, Grain</td>
<td>65 bu.</td>
<td></td>
</tr>
<tr>
<td>1234</td>
<td>3</td>
<td>5.00</td>
<td>4.50</td>
<td>N/A</td>
<td>Rains</td>
<td>Soybeans, Manured, Double Crop</td>
<td>38 bu.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fescue Pasture</td>
<td>4.5 Tons</td>
</tr>
</tbody>
</table>

**PLAN TOTALS:** 27.90 24.10

<table>
<thead>
<tr>
<th>LI</th>
<th>Potential Leaching</th>
<th>Technical Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2</td>
<td>Low potential to contribute to soluble nutrient leaching below the root zone.</td>
<td>None</td>
</tr>
<tr>
<td>&gt;= 2 &amp; &lt;= 10</td>
<td>Moderate potential to contribute to soluble nutrient leaching below the root zone.</td>
<td>Nutrient Management (590) should be planned.</td>
</tr>
<tr>
<td>&gt; 10</td>
<td>High potential to contribute to soluble nutrient leaching below the root zone.</td>
<td>Nutrient Management (590) should be planned. Other conservation practices that improve the soils available water holding capacity and improve nutrient use efficiency should be considered. Examples are Cover Crops (340) to scavenge nutrients, Sod-Based Rotations (328), Long-Term No-Till (778), and edge-of-field practices such as Filter strips (393) and Riparian Forest Buffers (391).</td>
</tr>
</tbody>
</table>
The Waste Utilization table shown below summarizes the waste utilization plan for this operation. This plan provides an estimate of the number of acres of cropland needed to use the nutrients being produced. The plan requires consideration of the realistic yields of the crops to be grown, their nutrient requirements, and proper timing of applications to maximize nutrient uptake.

This table provides an estimate of the amount of nitrogen required by the crop being grown and an estimate of the nitrogen amount being supplied by manure or other by-products, commercial fertilizer and residual from previous crops. An estimate of the quantity of solid and liquid waste that will be applied on each field in order to supply the indicated quantity of nitrogen from each source is also included. A balance of the total manure produced and the total manure applied is included in the table to ensure that the plan adequately provides for the utilization of the manure generated by the operation.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
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<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1234</td>
<td>1</td>
<td>S75</td>
<td>Norfolk</td>
<td>16.50</td>
<td>9.50</td>
<td>Small Grain Overseed</td>
<td>1.0 Tons</td>
<td>10/1-3/31</td>
<td>50</td>
<td>0</td>
<td>0</td>
<td>Irrig.</td>
<td>50</td>
<td>27.74</td>
<td>0.00</td>
<td>263.52</td>
</tr>
<tr>
<td>1234</td>
<td>1</td>
<td>S75</td>
<td>Norfolk</td>
<td>16.50</td>
<td>9.50</td>
<td>Hybrid Bermudagrass Hay</td>
<td>6.5 Tons</td>
<td>3/1-9/30</td>
<td>296</td>
<td>0</td>
<td>0</td>
<td>Irrig.</td>
<td>296</td>
<td>164.22</td>
<td>0.00</td>
<td>1,560.04</td>
</tr>
<tr>
<td>1234</td>
<td>2</td>
<td>S75</td>
<td>Goldsboro</td>
<td>12.40</td>
<td>10.10</td>
<td>Corn, Grain</td>
<td>120 bu.</td>
<td>2/1-5-6/30</td>
<td>148</td>
<td>0</td>
<td>0</td>
<td>Irrig.</td>
<td>148</td>
<td>82.11</td>
<td>0.00</td>
<td>879.28</td>
</tr>
<tr>
<td>1234</td>
<td>2</td>
<td>S75</td>
<td>Goldsboro</td>
<td>12.40</td>
<td>10.10</td>
<td>Wheat, Grain</td>
<td>65 bu.</td>
<td>9/1-4/30</td>
<td>136</td>
<td>0</td>
<td>0</td>
<td>Irrig.</td>
<td>136</td>
<td>45.27</td>
<td>0.00</td>
<td>457.23</td>
</tr>
<tr>
<td>1234</td>
<td>3</td>
<td>S75</td>
<td>Rains</td>
<td>5.00</td>
<td>4.50</td>
<td>Forage Pasture</td>
<td>4.5 Tons</td>
<td>8/1-7/31</td>
<td>146</td>
<td>0</td>
<td>0</td>
<td>Irrig.</td>
<td>146</td>
<td>81.05</td>
<td>0.00</td>
<td>364.49</td>
</tr>
</tbody>
</table>

Notes: 1. In the tract column, - symbol means leased, otherwise, owned. 2. Symbol * means user entered data.

<table>
<thead>
<tr>
<th>Total Applied, 1,000 gallons</th>
<th>3,474.56</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Produced, 1,000 gallons</td>
<td>2,824.64</td>
</tr>
<tr>
<td>Balance, 1,000 gallons</td>
<td>-649.92</td>
</tr>
<tr>
<td>Total Applied, tons</td>
<td>0.00</td>
</tr>
<tr>
<td>Total Produced, tons</td>
<td>0.00</td>
</tr>
<tr>
<td>Balance, tons</td>
<td>0.00</td>
</tr>
</tbody>
</table>
### Waste Utilization Table

<table>
<thead>
<tr>
<th>Tract</th>
<th>Field</th>
<th>Source ID</th>
<th>Soil Series</th>
<th>Total Acres</th>
<th>Use Acre</th>
<th>Crop</th>
<th>RYE</th>
<th>Applic. Period</th>
<th>N</th>
<th>N</th>
<th>N</th>
<th>Applic. Method</th>
<th>Manure PA Nutrient Applied (lbs/A)</th>
<th>Liquid Manure Applied (acre)</th>
<th>Solids Manure Applied (lbs/A)</th>
<th>Liquid Manure Applied (Ft²)</th>
<th>Solid Manure Applied (Ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1234</td>
<td>1</td>
<td>S75</td>
<td>Norfolk</td>
<td>10.50</td>
<td>9.50</td>
<td>Small Grain Overseed</td>
<td>1.0 Tons</td>
<td>10/1-3/31</td>
<td>50</td>
<td>0</td>
<td>0</td>
<td>Irrig.</td>
<td>50</td>
<td>27.74</td>
<td>0.00</td>
<td>263.52</td>
<td>0.00</td>
</tr>
<tr>
<td>1234</td>
<td>1</td>
<td>S75</td>
<td>Norfolk</td>
<td>10.50</td>
<td>9.50</td>
<td>Hybrid Bermuda Grass Hay</td>
<td>6.5 Tons</td>
<td>3/1-9/30</td>
<td>296</td>
<td>0</td>
<td>0</td>
<td>Irrig.</td>
<td>296</td>
<td>164.22</td>
<td>0.00</td>
<td>1,580.04</td>
<td>0.00</td>
</tr>
<tr>
<td>1234</td>
<td>2</td>
<td>S75</td>
<td>Goldsboro</td>
<td>12.40</td>
<td>10.10</td>
<td>Wheat, Grain</td>
<td>65 bu.</td>
<td>9/1-4/30</td>
<td>136</td>
<td>0</td>
<td>0</td>
<td>Irrig.</td>
<td>54</td>
<td>30.18</td>
<td>0.00</td>
<td>304.82</td>
<td>0.00</td>
</tr>
<tr>
<td>1234</td>
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<td>S75</td>
<td>Goldsboro</td>
<td>12.40</td>
<td>10.10</td>
<td>Soybeans, Manured, Double Crop</td>
<td>38 bu.</td>
<td>4/1-9/15</td>
<td>149</td>
<td>0</td>
<td>0</td>
<td>Irrig.</td>
<td>149</td>
<td>82.66</td>
<td>0.00</td>
<td>834.89</td>
<td>0.00</td>
</tr>
<tr>
<td>1234</td>
<td>3</td>
<td>S75</td>
<td>Rains</td>
<td>5.00</td>
<td>4.50</td>
<td>Fescue Pasture</td>
<td>4.5 Tons</td>
<td>8/1-7/31</td>
<td>146</td>
<td>0</td>
<td>0</td>
<td>Irrig.</td>
<td>146</td>
<td>81.00</td>
<td>0.00</td>
<td>364.49</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**Total Applied, 1000 gallons:** 3,327.75

**Total Produced, 1000 gallons:** 2,824.64

**Balance, 1000 gallons:** -503.11

**Total Applied, tons:** 0.00

**Total Produced, tons:** 0.00

**Balance, tons:** 0.00

*Notes: 1. In the tract column, ~ symbol means leased, otherwise, owned. 2. Symbol * means user entered data.*
Chapter 3: Components of a Certified Animal Waste Management Plan

The Irrigation Application Factors for each field in this plan are shown in the following table. Infiltration rate varies with soils. If applying waste nutrients through an irrigation system, you must apply at a rate that will not result in runoff. This table provides the maximum application rate per hour that may be applied to each field selected to receive wastewater. It also lists the maximum application amount that each field may receive in any one application event.

Irrigation Application Factors

<table>
<thead>
<tr>
<th>Tract</th>
<th>Field</th>
<th>Soil Series</th>
<th>Application Rate (inches/hour)</th>
<th>Application Amount (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1234</td>
<td>1</td>
<td>Norfolk</td>
<td>0.50</td>
<td>1.0</td>
</tr>
<tr>
<td>1234</td>
<td>2</td>
<td>Goldsboro</td>
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</tr>
<tr>
<td>1234</td>
<td>3</td>
<td>Rains</td>
<td>0.40</td>
<td>1.0</td>
</tr>
</tbody>
</table>
The Available Waste Storage Capacity table provides an estimate of the number of days of storage capacity available at the end of each month of the plan. Available storage capacity is calculated as the design storage capacity in days minus the number of days of net storage volume accumulated. The start date is a value entered by the user and is defined as the date prior to applying nutrients to the first crop in the plan at which storage volume in the lagoon or holding pond is equal to zero.

Available storage capacity should be greater than or equal to zero and less than or equal to the design storage capacity of the facility. If the available storage capacity is greater than the design storage capacity, this indicates that the plan calls for the application of nutrients that have not yet accumulated. If available storage capacity is negative, the estimated volume of accumulated waste exceeds the design storage volume of the structure. Either of these situations indicates that the planned application interval in the waste utilization plan is inconsistent with the structure's temporary storage capacity.

<table>
<thead>
<tr>
<th>Source Name</th>
<th>Swine Wean-Finish Lagoon Liquid</th>
<th>Design Storage Capacity (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Date</td>
<td></td>
<td>180</td>
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<tr>
<td></td>
<td>Plan Year</td>
<td>Month</td>
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<tr>
<td>1</td>
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<td>1</td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>1</td>
<td>3</td>
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</tr>
<tr>
<td>2</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

* Available Storage Capacity is calculated as of the end of each month.
Chapter 3: Components of a Certified Animal Waste Management Plan

Required Specifications For Animal Waste Management

1. Animal waste shall not reach surface waters of the state by runoff, drift, manmade conveyances, direct application, or direct discharge during operation or land application. Any discharge of waste that reaches surface water is prohibited.

2. There must be documentation in the design folder that the producer either owns or has an agreement for use of adequate land on which to properly apply the waste. If the producer does not own adequate land to properly dispose of the waste, he/she shall provide evidence of an agreement with a landowner, who is within a reasonable proximity, allowing him/her the use of the land for waste application. It is the responsibility of the owner of the waste production facility to secure an update of the Nutrient Management Plan when there is a change in the operation, increase in the number of animals, method of application, receiving crop type, or available land.

3. Animal waste shall be applied to meet, but not exceed, the nitrogen needs for realistic crop yields based upon soil type, available moisture, historical data, climatic conditions, and level of management, unless there are regulations that restrict the rate of applications for other nutrients.

4. Animal waste shall be applied to land eroding less than 5 tons per acre per year. Waste may be applied to land eroding at more than 5 tons per acre per year but less than 10 tons per acre per year provided grass filter strips are installed where runoff leaves the field (see USDA, NRCS Field Office Technical Guide Standard 393 - Filter Strips).

5. Odors can be reduced by injecting the waste or by diskking after waste application. Waste should not be applied when there is danger of drift from the land application field.

6. When animal waste is to be applied on acres subject to flooding, waste will be soil incorporated on conventionally tilled cropland. When waste is applied to conservation tilled crops or grassland, the waste may be broadcast provided the application does not occur during a season prone to flooding (see "Weather and Climate in North Carolina" for guidance).
7. Liquid waste shall be applied at rates not to exceed the soil infiltration rate such that runoff does not occur offsite or to surface waters and in a method which does not cause drift from the site during application. No ponding should occur in order to control odor and flies.

8. Animal waste shall not be applied to saturated soils, during rainfall events, or when the soil surface is frozen.

9. Animal waste shall be applied on actively growing crops in such a manner that the crop is not covered with waste to a depth that would inhibit growth. The potential for salt damage from animal waste should also be considered.

10. Nutrients from waste shall not be applied in fall or winter for spring planted crops on soils with a high potential for leaching. Waste/nutrient loading rates on these soils should be held to a minimum and a suitable winter cover crop planted to take up released nutrients. Waste shall not be applied more than 30 days prior to planting of the crop or forages breaking dormancy.

11. Any new swine facility sited on or after October 1, 1995 shall comply with the following: The outer perimeter of the land area onto which waste is applied from a lagoon that is a component of a swine farm shall be at least 50 feet from any residential property boundary and canal. Animal waste, other than swine waste from facilities sited on or after October 1, 1995, shall not be applied closer that 25 feet to perennial waters.

12. Animal waste shall not be applied closer than 100 feet to wells.

13. Animal waste shall not be applied closer than 200 feet of dwellings other than those owned by the landowner.

14. Waste shall be applied in a manner not to reach other property and public right-of-ways.
15. Animal waste shall not be discharged into surface waters, drainageways, or wetlands by a discharge or by over-spraying. Animal waste may be applied to prior converted cropland provided the fields have been approved as a land application site by a "technical specialist". Animal waste shall not be applied on grassed waterways that discharge directly into water courses, and on other grassed waterways, waste shall be applied at agronomic rates in a manner that causes no runoff or drift from the site.

16. Domestic and industrial waste from washdown facilities, showers, toilets, sinks, etc., shall not be discharged into the animal waste management system.

17. A protective cover of appropriate vegetation will be established on all disturbed areas (lagoon embankments, berms, pipe runs, etc.). Areas shall be fenced, as necessary, to protect the vegetation. Vegetation such as trees, shrubs, and other woody species, etc., are limited to areas where considered appropriate. Lagoon areas should be kept mowed and accessible. Berms and structures should be inspected regularly for evidence of erosion, leakage, or discharge.

18. If animal production at the facility is to be suspended or terminated, the owner is responsible for obtaining and implementing a "closure plan" which will eliminate the possibility of an illegal discharge, pollution, and erosion.

19. Waste handling structures, piping, pumps, reels, etc., should be inspected on a regular basis to prevent breakdowns, leaks, and spills. A regular maintenance checklist should be kept on site.

20. Animal waste can be used in a rotation that includes vegetables and other crops for direct human consumption. However, if animal waste is used on crops for direct human consumption, it should only be applied pre-plant with no further applications of animal waste during the crop season.

21. Highly visible markers shall be installed to mark the top and bottom elevations of the temporary storage (pumping volume) of all waste treatment lagoons. Pumping shall be managed to maintain the liquid level between the markers. A marker will be required to mark the maximum storage volume for waste storage ponds.
22. Waste shall be tested within 60 days of utilization and soil shall be tested at least annually at crop sites where waste products are applied. Nitrogen shall be the rate-determining nutrient, unless other restrictions require waste to be applied based on other nutrients, resulting in a lower application rate than a nitrogen based rate. Zinc and copper levels in the soils shall be monitored and alternative crop sites shall be used when these metals approach excessive levels. pH shall be adjusted and maintained for optimum crop production. Soil and waste analysis records shall be kept for a minimum of five years. Poultry dry waste application records shall be maintained for a minimum of three years. Waste application records for all other waste shall be maintained for five (5) years.

23. Dead animals will be disposed of in a manner that meets North Carolina regulations.
Chapter 4: Tools for the Plan—Type A

Now that you understand what is in a waste management plan, you need to know what tools you can use to follow your plan. These tools include waste, soil, and plant analyses.

Waste Analysis

Nutrient concentrations vary in most wastes. A review of samples analyzed by the NCDA&CS Agronomic Division shows the available nutrients in animal waste can vary greatly. Accurate and consistent sampling techniques will provide the most reliable sample results. This allows the most precise determination of application rates to meet crop nutrient requirements.

Note: General recommendations for sampling are provided below. You should determine if your individual waste management plan has specific sampling requirements.

N.C. General Statute 143-215.10 requires that waste sampling be performed within 60 days of a waste application. Preferably, the sample should be taken as near the application time as possible prior to the waste application. However, if it is urgent to pump down a full lagoon or storage pond, you should not wait until you can sample and obtain the results. You should sample the day of irrigation. The results can later be used to determine the nutrients applied to the fields and identify the need for additional nutrients to complete crop production.

Waste users who fail to test each waste source before or just after land application are faced with a number of questions they simply may not be able to answer: Are they supplying plants with adequate nutrients? Are they building up excess nutrients that may ultimately move to surface waters or groundwater? Are they applying heavy metals at levels that may be toxic to plants and permanently alter soil productivity?

Because environmental damage and losses in plant yield and quality often happen before visible plant symptoms, growers should always have their waste analyzed by a competent laboratory. The NCDA&CS Agronomic Division can analyze waste samples and make agronomic recommendations regarding the use of animal waste as a fertilizer.

Waste Sampling

Proper sampling is the key to reliable waste analysis. Although laboratory procedures are extremely accurate, they have little value if the sample fails to represent the waste product.

Waste samples submitted to a laboratory should represent the average composition of the material that will be applied to the field. Reliable samples typically consist of material collected from a number of locations. Precise sampling methods vary according to the type of waste. The laboratory you use should have specific instructions on sampling, including proper containers to use and maximum holding or shipping times.
**Liquid Wastes**

Liquid waste samples submitted for analysis should meet the following requirements:

- Place sample in a sealed, clean, plastic container with about a 1 pint volume. Glass is not suitable because it is breakable and may contain contaminants.
- Leave 1 inch of air space in the plastic container to allow for expansion caused by the release of gas from the waste material.
- Refrigerate samples that cannot be shipped on the day they are collected; this will minimize chemical reactions and pressure buildup from gases.

Ideally, liquid wastes should be sampled after they are thoroughly mixed. Because this is sometimes impractical, samples can also be taken in accordance with the suggestions that follow.

**Lagoon Liquid**

Premixing the surface liquid in the lagoon is not needed, provided it is the only component that is being pumped. Growers with multistage systems should draw samples from the lagoon they intend to pump for crop irrigation.

Samples can be collected using a clean, plastic container similar to the one shown in Figure 4-1. One pint of material should be taken from at least eight sites around the lagoon and then mixed in the larger clean, plastic container. Waste should be collected at least 6 feet from the edge of the lagoon at a depth of about a foot. Shallower samples from anaerobic lagoons may be less representative than deep samples because oxygen transfer near the surface sometimes alters the chemistry of the solution. Floating debris and scum should be avoided.

One pint of mixed material should be sent to the laboratory. Galvanized containers should never be used for collection, mixing, or storage due to the risk of contamination from metals like zinc in the container.

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*Figure 4-1. Liquid waste sampling device.*
Liquid Slurry
Waste materials applied as a slurry from a pit or storage pond should be mixed prior to sampling. If you mix prior to sampling, the liquid sampling device pictured in Figure 4-1 can be used. If you wish to sample a storage structure without agitation, you must use a composite sampling device as shown in Figure 4-2. Waste should be collected from approximately eight areas around the pit or pond and mixed thoroughly in a clean, plastic container. An 8- to 10-foot section of 0.5- to 0.75-inch plastic pipe can also be used: extend the pipe into the pit; pull up the ball plug (or press your thumb over the end to form an air lock); and remove the pipe from the waste and release the air lock to deposit the waste in the plastic container.

For analysis, the laboratory requires 1 pint of material in a plastic container. The sample should not be rinsed into the container because doing so dilutes the mixture and distorts nutrient evaluations. However, if water is typically added to the waste prior to land application, a proportionate quantity of water should be added to the sample.

Solid Wastes
Solid waste samples should represent the average moisture content of the waste. Samples should be taken from approximately eight different areas in the waste, placed in a clean, plastic container, and thoroughly mixed. Sampling depth should be approximately 4 inches for poultry house litter and 18 inches for stockpiled wastes. Take samples around waterers and feeders in proportion to the space these occupy in the house. Cores should be taken from the top to the bottom of the accumulated waste (don’t sample the clay liner). Approximately 1 quart of the mixed sample should be placed in a plastic bag, sealed, and shipped directly to the laboratory. Samples stored for more than two days should be refrigerated. Figure 4-3 shows a device for sampling solid waste.
Who Can Analyze My Waste Sample?

The Plant/Waste/Solution/Media Section of the NCDA&CS Agronomic Division analyzes wastes, interprets analytical results, and provides management recommendations for citizens of North Carolina. Each sample must be accompanied by a completed copy of Form AD9 (Appendix C), the Waste Analysis Information Sheet, and an $8.00 fee for a routine analysis. If a grower suspects that a waste may have neutralizing value, then a determination of liming equivalent should be requested (extra $10 fee). These forms are available from your county Cooperative Extension center, from the NCDA&CS Regional Agronomist, from the Plant/Waste/Solution Advisory Section of the Agronomic Division, or online at www.ncagr.gov/agronomi.

Checks should be made payable to NCDA&CS. You can pay online by Visa and MasterCard for reports that are pending payment. You can also create an escrow account to prepay for reports by contacting the Agronomic Division at (919) 733-2655.

Directions for filling out form AD9 are printed on the bottom left corner of the form. To get the most value from your waste analysis, please take the time to fill out form AD9 completely and accurately. Contact your county Cooperative Extension center, NCDA&CS Regional Agronomist, or a technical specialist with the local Soil and Water Conservation District or Natural Resources Conservation Service for assistance in filling out form AD9. Be sure that the waste samples are labeled with your name, phone number, date, waste application method, and sample identification number. This is especially important when submitting several samples at one time. Additionally, waste samples from different farms should be submitted on separate information sheets with the appropriate farm ID.
Samples and completed information sheets mailed via the US Postal Service should be sent to:

NCDA&CS Agronomic Division
Plant/Waste/Solution/Media Section
1040 Mail Service Center
Raleigh NC 27699-1040

Samples mailed via FedEx or UPS should be sent to:

NCDA&CS Agronomic Division
Plant/Waste/Solution/Media Section
4300 Reedy Creek Road
Raleigh NC 27607

Private laboratories also offer some of these services and their fees vary. A good analytical service should always determine the concentrations of essential plant nutrients, including nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), and boron (B). A list of laboratories certified for animal waste analysis from the N.C. Department of Environmental Quality (NCDEQ) can be found at [http://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/laboratory-certification-branch/certified-laboratory-listings](http://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/laboratory-certification-branch/certified-laboratory-listings).

**What Does My Waste Analysis Report Tell Me?**

Samples submitted to the NCDA&CS Agronomic Division will be analyzed and the sender can look up their report online. The report lists the concentration of each plant nutrient and several potentially harmful elements (Figure 4-4). Specific concentrations of nutrients and other elements are reported on a weight basis for solid wastes (lb/ton); results for liquid wastes are reported on a volume basis (lb/1000 gal).

The most useful information is predicted nutrients available for the first crop. These levels are predicted on an as-is or wet basis. Nutrient availability is predicted based on estimates of breakdown of the waste and nutrient loss according to application method. Of the total nutrients predicted to be released for the first crop, 50 to 75 percent likely will become available during the first month. It is, therefore, important to apply wastes near the time required by plants. The remaining nutrients gradually become available over the next three months. Nutrients not available for the first crop are slowly released to available forms over time. For soils that do not readily leach with heavy rainfall, it is possible for nutrients to accumulate to significant quantities over time.

You should review the report to see if the analysis is within expected ranges for your waste. It is common for waste analyses to vary somewhat between seasons, due to excess rainfall or drought, or due to changes in management practices. However, you should compare your results to the results from previous waste reports to ensure that the results...
appear reasonable. If your results are significantly different from what you would expect, it is advisable to resample the waste. It is possible that the original sample may have been mislabeled or improperly collected and may not be representative of the waste.

Nutrients listed in the report as “available for the first crop” should be used in determining the actual application rate to meet a specific plant nutrient requirement. For the availability prediction to be reliable, growers must have properly identified the type of waste and the application method on the information sheet submitted to the laboratory.

It is important to understand that nutrient availability cannot be determined with 100 percent accuracy. Many variables, including the type of waste product and environmental factors (i.e., soil type, rainfall, temperature, and general soil conditions) influence the breakdown of the waste and nutrient loss. NCDA&CS waste analysis reports provide a realistic estimation of nutrient availability based on type of waste and application method.

Animal waste management regulations require you to maintain your waste analysis reports for a minimum of three years if you have a State Nondischarge Permit and five years if you have a NPDES Permit. This is to see if there is consistency in nutrient content and to justify your application rates.

A copy of your waste analysis reports is available at the NCDA&CS web site and can be accessed by you or your county Cooperative Extension agent. Print and maintain a copy of the reports with your records. Please consult Cooperative Extension or a NCDA&CS Regional Agronomist if you need assistance in interpreting your waste analysis results.
### Nutrient and Other Measurements

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<th>Sample Information</th>
<th>Nutrient and Other Measurements</th>
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<tbody>
<tr>
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<td>Nitrogen (N) (ppm)</td>
</tr>
<tr>
<td>Waste Code: ALF</td>
<td>P (ppm)</td>
</tr>
<tr>
<td>Description: Swine-Farrow to Wean</td>
<td>K (ppm)</td>
</tr>
<tr>
<td>Lagoon</td>
<td>Ca (ppm)</td>
</tr>
<tr>
<td>Comments:</td>
<td>Mg (ppm)</td>
</tr>
<tr>
<td></td>
<td>S (ppm)</td>
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<td>EC (mS/cm)</td>
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### Application Method

- **Irrigation**

### Estimate of Nutrients Available for First Crop (lb / 1000 gal.)

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<th>Ca</th>
<th>Mg</th>
<th>S</th>
<th>Fe</th>
<th>Mn</th>
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<th>Cu</th>
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### Other Elements (lb / 1000 gal.)

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<th>Ni</th>
<th>Cd</th>
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### Agronomist's Comments:

Hunter G. Landis 3/30/2016 4:09 PM

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Reprogramming of the laboratory-information-management system that makes this report possible is being funded through a grant from the North Carolina Tobacco Trust Fund Commission.

*Thank you for using agronomic services to manage nutrients and safeguard environmental quality.*

- Steve Troxler, Commissioner of Tobacco Trust Fund Commission
Soil Analysis

While experienced growers can usually recognize a well-nourished crop, it is not possible to look at a soil and predict if the soil is too acidic or if there are proper amounts of the essential nutrients present. Soils in North Carolina vary in their need for lime and other nutrients, depending on soil characteristics, previous fertilization levels, and nutrient requirements of the crop. The goal of soil testing is to find out enough about the soil to provide economically and environmentally sound nutrient and lime recommendations. Soil testing is not a perfect science, but it provides the most reasonable approach for growers to assess soil pH and plant-available nutrients, to determine the need for lime and fertilizers, and to avoid losses and environmental damage from improper lime and fertilization practices.

Animal waste management regulations require soil sampling at least once every three years for every field that received waste. The NCDA&CS Agronomic Division can analyze soil samples and make agronomic recommendations for lime and fertilizer applications. NCDA&CS routinely soil tests for free most of the year (April 1 through late November). From late November through March 31, however, a $4.00 peak-season fee is charged for the processing of all soil samples. If a grower wishes to have specific heavy metals analyzed (arsenic, cadmium, chromium, lead, nickel, and selenium) there is a $25 fee.

Sampling instructions, information sheets, and boxes are provided at no charge and can be obtained from county Cooperative Extension centers, from Regional Agronomists of the Agronomic Division, and from many businesses selling lime or fertilizer.

Samples and completed information sheets mailed via the US Postal Service should be sent to:

NCDA&CS Agronomic Division
Soil Testing Section
1040 Mail Service Center
Raleigh NC 27699-1040

Samples mailed via FedEx or UPS should be sent to:

NCDA&CS Agronomic Division
Soil Testing Section
4300 Reedy Creek Road
Raleigh NC 27607

Many Cooperative Extension centers mail samples or transport them to the lab for producers at no charge. Check with your local center for more information.

Copies of your soil analysis reports are available at the NCDA&CS web site and can be accessed by you or your county Cooperative Extension agent. Print and maintain a copy of the reports with your records. Please consult Cooperative Extension or a NCDA&CS Regional Agronomist if you need assistance in interpreting your soil analysis results.
Every soil sample you submit for testing should consist of about 15 to 20 cores taken at random locations throughout one field or area. A sample should include cores from no more than about 20 acres, even if the soil appears to be uniform over a larger area. Keep in mind that each sample should represent only one general soil type or condition. If the field you are sampling contains areas that are obviously different in slope, color, drainage, and texture, and if those areas can be fertilized separately, submit a separate sample (consisting of 15 to 20 cores) for each area (Figure 4-5). The 15- to 20-core sample you have collected will most likely be more soil than the box will hold. Before filling the box, pulverize the cores and mix them thoroughly in a clean, plastic bucket. Then fill the sample box about two-thirds full with this mixture.

When collecting samples, avoid small areas where the soil conditions are obviously different from those in the rest of the field—for example, wet spots, old manure and urine spots, places where wood piles have been burned, severely eroded areas, old building sites, fence rows, spoil banks, and burn-row areas. Because samples taken from these locations would not be typical of the soil in the rest of the field, including them could produce misleading results. Areas within a field where different crops have been grown in the past should be sampled separately, even if you now plan to grow the same crop in the whole field. Areas that have been limed and fertilized differently from the rest of the field should also be sampled separately.

Collect your samples with stainless steel or chrome-plated sampling tools and plastic buckets to avoid contaminating the samples. Avoid brass, bronze, or galvanized tools. Make sure that the buckets and sampling tools are clean and free of lime and fertilizer residues. Even a small amount of lime or fertilizer transferred from the sampling tools to the soil can seriously contaminate the sample and produce inaccurate results.
For areas in which field crops are grown, collect samples to the same depth that the field is plowed (usually about 8 inches) because this is the zone in which lime and fertilizer have been incorporated (Figure 4-6). For fields where soil is not disturbed due to conservation tillage or where perennial crops such as fescue, alfalfa, and turf are being maintained, samples taken to a depth of 4 inches will best represent the crop’s lime and fertilizer needs. Where these perennial crops are to be established, however, sample to the regular plow depth.

Once the soil test levels are measured, the final fertilizer and lime suggestions must be made. Fertilizer recommendations for commercial users are given on a pound per acre basis, nutrient by nutrient. Lime recommendations are in tons per acre.

![Figure 4-6. Sample to a depth of 8 inches in fields plowed for row crops and 4 inches where perennial pasture or turf crops are grown.](image)

**What Does My Soil Test Report Tell Me?**

Your waste utilization plan is designed to apply nitrogen at agronomic rates. In North Carolina, nitrogen is not measured by the soil testing laboratory. But a soil test is still an essential tool in implementing a waste utilization plan (Figure 4-7). The most immediate need for a soil test is to ensure that soil pH is within the desired range for the soil and crops you are growing. In addition, a soil test can be used to monitor nutrient accumulation, and provides information that will help you do a better job of managing the land application site. Only the most essential items will be discussed here. For more information, please consult Cooperative Extension or an NCDA&CS Agronomist.

**Soil pH and Lime**

Soil pH affects the availability of nutrients required for plant growth. An incorrect soil pH will reduce crop growth and yield, resulting in less nutrient uptake and more potential for environmental problems. Soils in North Carolina are naturally acidic, meaning that they have a low pH. Adding high amounts of ammonia, ammonium, or urea nitrogen
## Soil Report

**Mehlich-3 Extraction**

**Sample ID:** DCF01

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Recommendations:</strong></td>
<td>Lime History:</td>
</tr>
<tr>
<td><strong>Crop:</strong></td>
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</tr>
<tr>
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<tr>
<td><strong>History:</strong></td>
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<td><strong>N:</strong></td>
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<tr>
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<tr>
<td><strong>Nutrients (lb/acre):</strong></td>
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<tr>
<td><strong>Crop:</strong></td>
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</table>

**Test Results [units - W/V in g/cm²; CEC and Na in meq/100 cm²; NO₃-N in mg/dm³]:**

- **Soil Class:** Mineral
  - **HM%** 0.58 0.51 0.60
  - **W/V** 1.09 1.13 1.02
  - **CEC** 6.0 4.5 5.1
  - **BS%** 5.0 4.5 5.1
  - **Ac** 66 61 35
  - **pH** 5.6 5.5 4.6
  - **P-I** 60 50 48
  - **K-I** 3.0 1.5 2.5
  - **Ca%** 60 25 20
  - **Mg%** 60 25 20
  - **S-I** 47 43 20
  - **Mn-I** 16 11 4
  - **Mn-Al1** 27 24 19
  - **Mn-Al2** 20 17 12
  - **Zn-I** 69 34 31
  - **Zn-Al** 69 34 31
  - **Cu-I** 80 161 118
  - **Na** 0.1 0.0 0.0
  - **ESP** 2.0 0.0 0.0
  - **SS-I** 0.0 0.0 0.0
  - **NO₃-N** 0.0 0.0 0.0

**Sample ID:** DCF02

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<tr>
<td><strong>Lime:</strong></td>
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  - **BS%** 5.0 4.5 5.1
  - **Ac** 66 61 35
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  - **P-I** 60 50 48
  - **K-I** 3.0 1.5 2.5
  - **Ca%** 60 25 20
  - **Mg%** 60 25 20
  - **S-I** 47 43 20
  - **Mn-I** 16 11 4
  - **Mn-Al1** 27 24 19
  - **Mn-Al2** 20 17 12
  - **Zn-I** 69 34 31
  - **Zn-Al** 69 34 31
  - **Cu-I** 80 161 118
  - **Na** 0.1 0.0 0.0
  - **ESP** 2.0 0.0 0.0
  - **SS-I** 0.0 0.0 0.0
  - **NO₃-N** 0.0 0.0 0.0

**Sample ID:** DCF03

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<td><strong>B:</strong></td>
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<td><strong>Nutrients (lb/acre):</strong></td>
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<td><strong>Crop:</strong></td>
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<td><strong>Cu:</strong></td>
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  - **K-I** 3.0 1.5 2.5
  - **Ca%** 60 25 20
  - **Mg%** 60 25 20
  - **S-I** 47 43 20
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  - **Mn-Al1** 27 24 19
  - **Mn-Al2** 20 17 12
  - **Zn-I** 69 34 31
  - **Zn-Al** 69 34 31
  - **Cu-I** 80 161 118
  - **Na** 0.1 0.0 0.0
  - **ESP** 2.0 0.0 0.0
  - **SS-I** 0.0 0.0 0.0
  - **NO₃-N** 0.0 0.0 0.0

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Repurposing of the laboratory-information-management system that makes this report possible is being funded through a grant from the North Carolina Tobacco Trust Fund Commission.

Thank you for using agronomic services to manage nutrients and safeguard environmental quality.

---

Steve Trax
sources will also quickly acidify the soil. Low pH increases the availability of metals such as aluminum, zinc, copper, and manganese, all of which can become toxic to plants at high concentrations. Depending on the amount of nitrogen applied, soils with high metal concentrations and low pH may require additions of lime in order to maintain the pH in a range suitable for plant growth. Dolomitic lime also supplies calcium and magnesium, which are essential for crop growth.

The soil test report indicates the amount of lime required, in tons per acre, to achieve the target pH for your soil type and crop. Soils with high amounts of organic matter have a much lower target pH than soils with low organic matter contents. For this reason, soil samples received at the lab are separated into Mineral, Mineral-Organic, and Organic classes based on their Humic Matter content (HM% on the report), weight per volume (W/V) and color. For most crops, the desired pH is 6.0 for Mineral (MIN) soils, 5.5 for Mineral-Organic (M-O) soils, and 5.0 for Organic (ORG) soil classes. Current laws require you to lime fields that are in waste application systems to meet soil test recommendations. You should also maintain proof of this liming should it be requested during a site inspection.

**CEC**

The cation exchange capacity (CEC) gives an indication of the ability of the soil to hold nutrients. In North Carolina, CEC increases with increasing clay content or increasing organic matter content. Soils with a low CEC (1 to 5 milliequivalents per 100 cubic centimeters) have low clay and organic matter contents, and nutrients such as nitrogen, potassium, and magnesium may leach from these soils during periods of excess rainfall. These soils require more frequent application of nutrients at lower rates to ensure adequate availability throughout the growing season. Micronutrients applied to soils with low CEC can become toxic to plants at lower index levels than on soils with a CEC above 5 meq/100cc.

**Nutrient Index Values**

The soil nutrient concentrations on an NCDA&CS soil test are reported as index values. Index values can be used as a means of predicting soil fertility levels or potential heavy metal toxicities. Essentially, the index system was developed to relate soil fertility levels to the likelihood of a crop yield increase resulting from a fertilizer application (Table 4-1). For phosphorus and potassium, no response to nutrient additions is generally expected for most crops when the index value is above 50. Micronutrients are required in much lower amounts, so responses are not expected when index values are above 25. When soil test index values are less than these critical levels, the soil test report will indicate the amount of nutrient to apply for optimum plant growth in the Recommendations section of the report.
Table 4-1. Relationship Between Soil Test Index and Crop Response

<table>
<thead>
<tr>
<th>Soil Test Index</th>
<th>Expected Crop Response to Nutrient Application</th>
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<tbody>
<tr>
<td>Range</td>
<td>Rating</td>
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<tr>
<td>0 to 10</td>
<td>Very Low</td>
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<tr>
<td>11 to 25</td>
<td>Low</td>
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<tr>
<td>26 to 50</td>
<td>Medium</td>
</tr>
<tr>
<td>51 to 100</td>
<td>High</td>
</tr>
<tr>
<td>100+</td>
<td>Very High</td>
</tr>
</tbody>
</table>

Note: Soil test index values above 100 indicate excessive amounts are present in soil.

How Can a Soil Test Be Used to Adjust and Monitor Waste Utilization Plans?

Soil tests can be used to help determine the priority nutrient. The priority nutrient is the nutrient most likely to cause an adverse environmental or plant health effect. Nitrogen is the priority nutrient most often. As a result, most waste application rates are based on supplying crop nitrogen (N) needs. The idea is to not apply N at rates greater than the crop can use because the nitrate form of nitrogen can move through the soil and threaten groundwater quality. Some nutrients found in animal waste may be stored in the soil just as one stores money in a bank. In most soils, phosphorus (P), copper (Cu), and zinc (Zn) are not subject to leaching at a soil pH normally used to grow crops and remain in the soil until taken up by plants. As Cu and Zn continue to accumulate they may become toxic to plants. The level at which toxicity occurs depends on the concentration of the element in the soil, sensitivity of the crop, soil pH, and the cation exchange capacity (CEC). In addition, P can become a source of nonpoint pollution if soil erodes from the site and moves into nearby surface waters.

Ranking Fields for Waste Applications

By monitoring soil test index values for various nutrients, you can take steps to avoid soil buildup to undesirable levels. In general, waste products should be applied as a priority in fields where there is evidence of the greatest need for nutrients. Because the nutrients in animal manures are not balanced with respect to crop needs, there is potential for buildup of some nutrients in the soil when manures are applied based on N rates. Examples of nutrients that have been shown to increase in the soil with repeated animal manure applications are phosphorus (P), copper (Cu) and zinc (Zn). Because of this, regulations have been adopted that require monitoring of these nutrient levels.

Phosphorus—Phosphorus levels in the soil can potentially lead to loss of phosphorus to surface waters. The Phosphorus Loss Assessment Tool (PLAT) has been developed to assess the potential loss of phosphorus from agricultural fields. This assessment may be required for animal producers as a permit condition or on a site-specific basis. The tool assists a technical specialist in making a determination of the potential of P to impact surface waters, as well as develop management practices to reduce P loss from fields. In cases where potential impact from excess P is high, a producer may have to reduce or eliminate manure applications to any fields in the plan that show such a rating. Assessment
of P loss with PLAT requires specialized training; as such this manual does not offer specifics on PLAT determinations. Appendix C has a fact sheet on PLAT and information on deep soil sampling.

**Copper and Zinc**—These micronutrients are required by plants. Typically though, when manures are applied based on N rates, these micronutrients are over-applied. Regulatory limits have been set for soil test levels of Cu and Zn.

<table>
<thead>
<tr>
<th></th>
<th>Caution level*</th>
<th>Critical toxic level**</th>
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<tbody>
<tr>
<td>Copper Index</td>
<td>2000</td>
<td>3000</td>
</tr>
<tr>
<td>Zinc Index</td>
<td>2000¹</td>
<td>3000¹</td>
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</table>

* Caution level means that producer should seek alternate sites for manure application
** Critical toxic level means that no more manure application is allowed
¹ These levels are appropriate for all crops except peanuts, where the caution level is 300 and the critical toxic level is 500. Maintaining a pH of 6.0 or higher is also advised.

Producers should closely monitor the results of the soil tests for these nutrients. Should there be fields in the waste plan that exhibit these levels, or otherwise show a sharp, unexplained increase in soil test levels, advice should be sought from a technical specialist or agronomist.

**Plant Analysis**

Nutrient elements required for plant growth are termed “essential.” Healthy plants contain predictable concentrations of these elements. Major elements (nitrogen, phosphorus, and potassium) are required in larger amounts. Secondary elements (calcium, magnesium, and sulfur) are required in smaller amounts. Micronutrients (iron, manganese, zinc, copper, boron, molybdenum, and chlorine) are required in much smaller amounts. If these elements are present in inadequate levels, then the plant suffers from a nutrient deficiency that reduces growth and yield. In some cases, if these nutrients are present in higher concentrations than required, the plant will suffer from a nutrient toxicity. In either case, the plant is not healthy and therefore is not removing nutrients from the soil at its fullest capabilities. Plant analysis can be used to distinguish between nutrient deficiency and toxicity as compared to sufficiency.

A plant analysis has three main applications:

- To confirm a suspected nutrient deficiency or toxicity when visual symptoms are present.
- To monitor plant nutrient status in an effort to achieve optimum yield and quality while protecting the environment.
- To serve as a basis along with a soil test for fine tuning fertilization programs.

You should consider plant analysis if you see indications that your crops are not healthy. These indications include leaf yellowing or spotting, wilting (even with sufficient moisture), and reduced growth or plant death.
You can confirm a suspected deficiency by plant analysis before applying a corrective treatment. Numerous cases can be described where incorrect diagnosis of a crop problem in the field may lead to crop failures, as well as costly and ineffective corrective treatments.

The monitoring role of a plant analysis is not used as extensively; however, it offers the opportunity to maintain high quality production with maximum efficiency and a minimum of nutrient deficiency problems. To provide a means of noting changes in nutrient content, sample each year or on a regular basis and compare test results from one sample to the next. Study carefully upward or downward trends along with previous manure or fertilizer inputs to identify a potential nutrient deficiency, excess, or imbalance. Corrective treatments can be applied before significant losses in yield or quality occur.

Visual observations, knowledge of the site, a soil test, and the plant analysis results provide an effective means of evaluating the nutrient status of the soil-plant environment. However, a plant analysis result may not solve every problem or uncover all unseen nutrient deficiencies or toxicities. When a nutrient deficiency is confirmed by a plant analysis or an unseen deficiency is uncovered, a corrective treatment may not always be applicable to the sampled crop. Treatments may be specified for future growing seasons or additional plant and soil samples may be needed to fully evaluate the suspected deficiency.

A plant analysis may indicate that a nutrient deficiency or toxicity does not exist. Therefore, a factor other than nutrition may be responsible for poor plant growth or visual symptoms. This information is invaluable in problem solving. In order to use the plant analysis technique effectively, take care when collecting, preparing, and sending plant tissue to the laboratory.

A recent soil test result can be helpful when interpreting a plant analysis. When visual symptoms of a suspected nutrient deficiency are present, take a soil sample at the same time from root zones of plants sampled. In this way, an evaluation of the soil in the affected area can be made along with the plant analysis result. Sampling healthy and unhealthy plants, and their respective soil, is very effective in problem solving.

Sampling instructions, information sheets, and shipping envelopes are provided at no charge and can be obtained at county Cooperative Extension centers or from Regional Agronomists of the Agronomic Division. The fee is $5.00 for most crops. The fee is $7 for certain crops that require extra services. This applies to cotton, strawberry, and vinifera grapes, which must be tested for petiole nitrates, and to alfalfa, cole crops, poinsettias, and spinach, which must be tested for molybdenum.
Samples and completed information sheets mailed via the US Postal Service should be sent to:

NCDA&CS Agronomic Division
Plant/Waste/Solution/Media Section
1040 Mail Service Center
Raleigh NC 27699-1040

Samples mailed via FedEx or UPS should be sent to:

NCDA&CS Agronomic Division
Plant/Waste/Solution/Media Section
4300 Reedy Creek Road
Raleigh NC 27607

How Can Plant Analysis Be a Predictive and Diagnostic Tool?

Additional nutrient applications may be needed based on nutrient deficiencies indicated in a plant analysis report. Repeated plant analyses, during the growth cycle of a plant or from one season to another, can show changes that occur with time as a result of applied fertilizer treatments. These analyses can provide a guide for corrective treatments. Supplemental treatments can be scheduled based on a series of analyses. Such analyses and the maintenance of leaf analysis result logs are invaluable. Base supplemental applications of N on a plant analysis, particularly when there is a suspected or anticipated N deficiency. If assistance is needed, contact a technical specialist prior to making additional waste applications based on the results of a plant analysis.

Forage Analysis

Nitrate poisoning in animals is a potential problem in North Carolina due to the high levels of nitrogen applied to forages, which can commonly result in levels of nitrate above what is normally considered safe. Many factors affect pasture and forage quality, including type of species, stage of maturity, soil condition, climate, storage, and handling. Laboratory analysis is the best way to determine a forage’s nutrient content and the potential for nitrate toxicity. Producers should periodically monitor the quality of their pastures and hay to make sure animal nutrient requirements are being met and that fertilization practices are appropriate.

Forage sampling differs from plant analysis, which is used to determine nutrient status for crops. Forage sampling is a test to help determine if there are potential problems with using a crop for animal feed. For a $10.00 fee, the NCDA&CS Food and Drug Protection Division will analyze forages for nutritional composition to determine safety as a food source for animals.

Forage analysis forms (see Appendix C) are available from the NCDA&CS at [www.ncagr.gov/fooddrug/feed/index.htm](http://www.ncagr.gov/fooddrug/feed/index.htm) or from county Cooperative Extension centers.
Samples mailed via the US Postal Service should be sent to:

NCDA&CS
Food and Drug Protection Division
Attn: Forage Testing
1070 Mail Service Center
Raleigh, NC 27699-1070

Samples mailed via FedEx or UPS should be sent to:

NCDA&CS
Food and Drug Protection Division
Attn: Forage Testing
4000 Reedy Creek Rd.
Raleigh, NC 27607

How to Sample Pastures for Forage Analysis
1. Use a gallon bag to hold the collected tissue. Be sure there are no contaminants on your hands or on the collected tissue.
2. Walk the pasture much the same way you would for soil sampling or scouting for insects. Take a sample of grazeable vegetation by plucking or grabbing a few leaves between the thumb and index and middle finger. Snap the leaves at the same height as the animals are grazing, especially if you want to know what is being consumed at the time.
3. Complete the form and ship the sample.

How to Sample Hay for Forage Analysis
1. Use a core sampler forage probe to collect a representative sample from 10 to 15 bales from a lot of hay. A lot of hay is defined as hay cut from the same field and grown under similar conditions. Use a pint sized bag to hold the collected sample.
2. Complete the form and ship the sample.

Other Testing
Owners of waste application sites may also wish to sample surface water and groundwater supplies once a year to confirm that nutrient-management programs are not adversely affecting the environment. This is especially advisable for new operations, so as to establish background levels of nitrate-nitrogen and phosphorus.
Review Questions

1. How do you obtain the nutrient value of your lagoon liquid or animal waste?

2. What is meant by the term “representative sample”?

3. What types of tools should be used for waste and soil analysis?

4. Who should you contact for assistance with soil, waste, or plant tissue sampling?

5. Under what conditions should you consider NOT using a field for waste application?

6. When would you consider using plant analysis to help with your waste management program?
Chapter 5: System Components and Operation—Type A

Animal waste management systems are an important part of animal production operations. They are composed of structures and devices that collect, transport, recycle (flush), treat, store, and land-apply the animal waste products resulting from the production of animals. As an operator of such a system, you will become knowledgeable about system components and their proper operation and maintenance. Improper operation could lead to a spill or runoff of the wastes, both of which are violations of state law as discussed in Chapter 2.

Type A animal waste management systems rely primarily on an anaerobic lagoon and soil/plant systems for the treatment of waste. These systems are most often used to treat animal waste generated by animals, such as swine and poultry, that produce a low-fiber waste. These systems generally include the following components: anaerobic lagoon; pumps, pipes, and associated hardware that convey the waste from the point of generation to the final treatment/disposal site; flushing systems; solids separation equipment; irrigation equipment; and land-application site and crops.

Lagoons

Lagoons are earthen structures that treat and store animal manure. They function as digesters where bacteria decompose organic matter. Anaerobic lagoons are used in the swine and poultry industry because of their efficiency and cost advantages. Anaerobic means the waste is treated without aeration (or oxygen) or mixing devices. A properly sized and operated lagoon reduces organic material (which is the major source of odor), reduces the nitrogen concentration of the waste, and allows solids to settle out. Most of the phosphorus will accumulate in the sludge in the bottom of the lagoon.

Lagoon Design and Construction

Proper lagoon design and construction is required to meet the requirements of N.C. Dam Safety Laws. A failure of a lagoon dam could affect the life, health, property, and public well-being of others in varying degrees, depending on the size and location of the dam. If a dam is less than 25 feet in height or the lagoon has less than 50 acre-feet of capacity, the system is not subject to the dam safety regulations. The exception is when a dam is classified as “high hazard.” A dam classified as high hazard is subject to the regulations regardless of size. High hazard dams are those located where their failure will likely cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, primary highways, or major railroads.

Proper design and construction will also minimize the risk to surface water or groundwater as a result of lagoon overflow or seepage. An undersized lagoon increases the need for more intensive management and pumping frequency. It also increases odor potential and nutrient (nitrogen and phosphorus) levels of water that leaves the lagoon, either as flush
water or as irrigation water to a field. An undersized lagoon also increases the rate of sludge (solids) buildup in the lagoon and requires more frequent sludge removal.

The capacity of an anaerobic lagoon (Figure 5-1) includes volumes designed for:

- **Sludge**—Organic solids that cannot be further decomposed by anaerobic bacteria and accumulate in the bottom of a lagoon.
- **Permanent liquid treatment**—The amount of liquid that should always be present in a lagoon for optimal bacterial activity.
- **Temporary liquid storage**—A design volume based on the average amount of wastewater, excess rainfall over evaporation, fresh washwater, and outside drainage that enters the lagoon during a storage period when liquid cannot be irrigated onto a growing crop. Most lagoon design volumes are based on a 180-day storage period.
- **Heavy rainfall factor**—A minimum volume that must be equal to or greater than the depth of a 25-year, 24-hour storm on the lagoon surface to allow for chronic rainfall periods.
- **25-year, 24-hour storm**—The maximum 24-hour precipitation event with a probable recurrence interval of once in 25 years as defined by the National Weather Service. These storm amounts vary from county to county, and generally range from 5 to 9 inches in North Carolina.
- **Structural Freeboard**—The distance from the top of the lagoon dam or dike elevation to the highest waste liquid elevation (at least 1 foot) to protect structural integrity. This distance is in addition to the 25-year, 24-hour storm and the heavy rainfall factor.

The term **freeboard** describes the distance from the top of the lagoon dam or dike elevation to the wastewater level as recorded on the FRBD-1 form (discussed in Chapter 7).

*Note: Heavy rainfall factor is not required for lagoons designed before September 1, 1996. Although inclusion of this factor is not required, it is recommended that lagoon operators maintain storage to accommodate the heavy rainfall factor. See your original lagoon design or a technical specialist for more information.*

The **permanent storage volume** is the total of the sludge storage volume and the permanent liquid treatment volume.
**Liquid Level Gauging Device**

Lagoons must have a permanent readable marker inside the lagoon to assist with liquid level management. The marker shows the absolute maximum and minimum operating levels to indicate when pumping is needed and when pumping should stop. The markers should be routinely cleaned so you can easily observe the available storage. The marker’s location relative to the lagoon storage design can be seen in Figure 5-1. Lagoon level management will be discussed later in this chapter.

**Liners**

Lagoon liners are used to reduce the permeability (seepage) of the bottom and sidewalls of the lagoon. This prevents or restricts the potential for downward and lateral seepage of the wastes from the lagoon. The types of lagoon liners used are:

- **Clay**—Can usually be found near site; requires careful installation with proper compaction at the proper moisture content.
- **Bentonite**—Is blended with existing soil; has to come from sources outside North Carolina; freight is expensive.
- **Synthetic membrane**—Normally some type of plastic; requires careful installation by experienced contractor; easy to damage.

**Pipes**

Pipes are important because they convey the waste from the animal confinement houses to the lagoon and from the lagoon to the fields for irrigation. Pipes are also used to recycle lagoon water used to flush waste from the houses.
Factors that should be considered when choosing pipes include:

- **Material**—The pipe should be made of a durable material that can withstand contact with the waste. Plastic or concrete is usually more durable than metal.

- **Size**—The pipe must be large enough to carry the volume of waste without backup in the house. Recycle pipes that are too small can cause problems with pumps and motors. Pipes that are too large can allow solids buildup, which may clog the pipe.

- **Slope**—Pipes that carry waste from animal confinement houses to the lagoon should be on a slope of approximately 1 percent or greater to reduce the potential for solids buildup which may clog pipes.

- **Location**—Discharge pipes should be located where they will not cause problems, such as erosion of the lagoon liner or embankment, interference with traffic around the lagoon, or interference with diversion of surface water away from the lagoon. Pipes should not be installed in the embankment without proper engineering considerations. Pipes through embankments must have anti-seep collars or other devices. Pipes that are above ground must be properly supported with piers, posts, or a cradle to prevent sagging. In order to reduce odors, the pipe should discharge below the liquid surface. This also helps to minimize potential lagoon liner damage.

**Flush Systems**

Flushing waste into lagoons and storage ponds is a low-labor, sanitary method for manure management. It involves recycling lagoon water through a piping network and into tanks or pits, which then are manually or mechanically operated to send a set volume of water through the manure storage pits to flush the fresh manure into the lagoon.

Flush systems are very efficient but must be monitored for leaks and spills as these systems carry wastewater away from the lagoons. Flush systems may be prone to clogging or crystal buildup which reduces the efficiency of the system to remove manure solids, and can result in increased maintenance, cost of operation, and potential for pipe breakage. Management of crystal buildup and pipes will be covered in later sections in this chapter.

**Pumps**

Pumps used for land application of wastewater are generally straight centrifugal pumps when solids content is less than 4 percent. A centrifugal pump consists of an impeller rotating in a casing. Open impeller-type pumps are normally used for wastewater applications. A gate valve and discharge check valve are usually installed on the discharge side of the pump. The suction line and strainer should be floated in the lagoon so that the intake is about 18 inches below the water level and able to draw the most solids-free liquid. The pump should be located as far from the inlet pipe to the lagoon as possible. If the lagoon is located in an area where a prevailing wind direction exists, the pump should be located on the upwind side of the lagoon because solids tend to migrate to the downwind side.

Pumps are rated to deliver a set number of gallons at a given operating head (pressure) at a specified efficiency. Pump manufacturers provide pump curves for each of their pumps.
These curves show the relationship between head, horsepower, capacity, and efficiency. Pump curves can be used in case you need to modify your operating conditions from the original irrigation design. As pump models are discontinued it becomes more difficult to obtain this information for older pumps. Keep equipment specification information in a safe place, such as with your other operational records.

**Irrigation Systems**

A properly designed irrigation system provides the operator the opportunity to uniformly apply wastewater at agronomic rates without direct runoff from the site. However, a “good design” does not guarantee proper land application. The performance of a well-designed system can be ruined by poor management; likewise, a poorly designed system can sometimes provide good performance with proper, intensive management. You should be familiar with your system components, range of operating conditions, and maintenance procedures and schedules to keep your system in proper operating condition.

There are two primary types of wastewater irrigation systems: stationary and traveling systems.

**Stationary Sprinkler Systems**

Stationary systems for land application of lagoon liquid are usually permanent installations (lateral lines are PVC pipes permanently installed below ground). One of the main advantages of stationary sprinkler systems is that these systems are well suited to irregularly shaped fields. Thus, it is difficult to give a standard layout, but there are some common features between systems. To provide proper overlap, sprinkler spacings are normally 50 to 65 percent of the sprinkler wetted diameter. Sprinkler spacing is based on nozzle flow rate and desired application rate. Sprinkler spacings are typically in the range of 80 feet by 80 feet using single-nozzle sprinklers. Other spacings can be used and some systems are designed to use gun sprinklers (higher volume) on wider spacings. A typical layout for a permanent irrigation system is shown in Figure 5-2.

The minimum recommended nozzle size for wastewater is 1/4 inch. Typical operating pressure at the sprinkler is 50 to 60 pounds per square inch (psi). Sprinklers can operate in a full or partial circle. The system should be zoned (any sprinklers operated at one time constitutes one zone) so that all sprinklers are operating on about the same amount of rotation to achieve uniform application. Gun sprinklers typically have higher application rates; therefore, adjacent guns should not be operated at the same time (referred to as “head to head”).
Traveling Systems

Traveling systems are either cable-tow traveler, hard-hose traveler, center pivot, linear-move, or hose-drag systems.

The cable-tow traveler consists of a single-gun sprinkler mounted on a trailer with water being supplied through a flexible, synthetic fabric, rubber- or PVC-coated hose. Pressure rating on the hose is normally 160 psi. A steel cable is used to guide the gun cart.

The hard-hose traveler consists of a hose drum, a medium-density polyethylene (PE) hose, and a gun-type sprinkler. The hose drum is mounted on a multiwheel trailer or wagon. The gun sprinkler is mounted on a wheel or sled type cart referred to as the gun cart. Normally, only one gun is mounted on the gun cart. The hose supplies animal waste to the gun sprinkler and also pulls the gun cart toward the drum. The distance between adjacent pulls is referred to as the lane spacing. To provide proper overlap, the lane spacing is normally 70 to 80 percent of the gun wetted diameter. A typical layout for a hard-hose traveler irrigation system is shown in Figure 5-3.

The hose drum is rotated by a water turbine, water piston, water bellows, or by an internal combustion engine. Regardless of the drive mechanism, the system should be equipped with speed compensation so that the sprinkler cart travels at a uniform speed from the beginning of the pull until the hose is fully wound onto the hose reel. If the solids content of the wastewater exceeds 1 percent, an engine drive should be used.
Chapter 5: System Components and Operation—Type A

Nozzle sizes recommended on gun-type sprinklers are 0.50 to 1.34 inches in diameter and require operating pressures of 50 to 80 psi at the gun for uniform distribution. System operators should be knowledgeable of the relationships between nozzle size, flow rate, wetted diameter, and travel speed before interchanging different nozzle sizes. Operators should consult with a technical specialist before changing nozzle size to a size different than that specified in the certified waste management plan.

The use of center-pivot systems for wastewater irrigation is increasing. Center pivots are available in both fixed-pivot point and towable machines. They are available in size from single tower machines that cover around 5 acres to multitower machines that can cover several hundred acres. Center pivots use either rotary sprinklers, small guns, or spray nozzles. Drop-type spray nozzles offer the advantage of applying wastewater close to the ground at low pressure, which results in little wastewater drift due to wind.

Linear-move systems are similar to center pivot systems, except that neither end of the distribution pipe is anchored and travel is in a straight line. Drives at each end move the distribution pipe across the spray field. Animal waste is supplied through a feeder hose to one end of the distribution pipe. Depending on the type of sprinkler used, operating pressure ranges from 10 to 50 psi. These system types can only be used where large fields without drainage ditches exist.

Hose-drag applicators are another type of traveling system (also called an umbilical, dragline, or drag-hose system). Animal waste is pumped from the lagoon through a hose that continuously supplies an application toolbar or injection unit mounted to the back of a tractor. The tractor drags the umbilical hose across the field as the toolbar or injector unit discharges the animal waste. The tractor travels through the field in an S-shaped pattern, always turning away from the hose.

Hose-drag applicators are expensive and are practical only when applying animal waste at sites with large, flat fields. However, they reduce the time required for application because they don’t have to leave the field to fill up. And because there are no tanks, hose-drag applicators place less weight on the soil, reducing soil compaction.
In summary, below are several advantages and disadvantages for stationary and traveling irrigation systems:

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td><strong>Stationary Systems</strong></td>
<td></td>
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<tr>
<td>• good for small or irregular fields</td>
<td>• higher initial costs</td>
</tr>
<tr>
<td>• do not have to move equipment</td>
<td>• must protect from animals and equipment</td>
</tr>
<tr>
<td></td>
<td>• small bore sprinklers more likely to get plugged or broken</td>
</tr>
<tr>
<td></td>
<td>• no flexibility to move to other (new) fields</td>
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<table>
<thead>
<tr>
<th>Advantages</th>
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<tbody>
<tr>
<td><strong>Traveling Systems</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Cable Tow and Hard Hose Travelers</strong></td>
<td>• system is transportable</td>
</tr>
<tr>
<td></td>
<td>• application rate can be adjusted (speed and nozzle settings)</td>
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<td></td>
<td>• easily used for new fields</td>
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<td></td>
<td>• does not maximize the use of area for irregularly shaped fields</td>
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<tr>
<td></td>
<td>• impractical for small areas</td>
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**Center Pivot and Linear Move**
• application rate can be adjusted (speed and nozzle settings)
• easily used for new fields
• does not maximize the use of area for irregularly shaped fields
• impractical for small areas

**Wettable Acres**
Regardless of the type of irrigation system used, an assessment of either the effective irrigated acres or **wettable acres** must be performed. Wettable acres are the “useable” part of a field that actually receives the irrigated wastewater, as opposed to the total field size. Wettable acres are made by designated technical specialists with specialized training and often these assessments are made at the time of irrigation system installation or modification. For the operator’s purpose, the main thing to note is what the “useable” acres for each field in the waste plan is, as this is the area that is used in record keeping and the area that determines how much waste can be applied to each field.

**Pump-and-Haul Waste Application Systems**
Liquid applicators and tank spreaders are an alternative to irrigation systems for transporting and applying liquid waste slurries and lagoon sludges. As compared to irrigation, tank spreaders (honey wagons) have several advantages and disadvantages:

<table>
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<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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</thead>
<tbody>
<tr>
<td>• provides more transport mobility</td>
<td>• requires more time and labor</td>
</tr>
<tr>
<td>• allows direct soil injection</td>
<td>• higher operating costs</td>
</tr>
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<td></td>
<td>• requires improved travel roads and ability to drive in the field</td>
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Proper location and design of pumping and loading areas are necessary to protect equipment and operators and to avoid damaging the lagoon dike or embankment. Care should be taken to minimize spills during loading and transport.
Liquid tank spreaders must be accurately calibrated to apply wastes at proper rates. Calibration is the combination of settings and travel speed needed to apply wastes at a desired rate and to ensure uniform application. Calibration procedures for pump and haul systems are found at the end of Chapter 6.

**Operation and Maintenance**

**Lagoons**

An improperly operated and maintained lagoon can fail, resulting in the unplanned discharge of wastewater from the structure. Types of failure include leakage through the bottom or sides, overtopping, and breach of the dam. Assuming proper design and construction, the owner has the responsibility for ensuring structure safety. Items that may lead to lagoon failures include:

- Lagoon liquid levels—high levels are a safety risk.
- Excess surface water flowing into the lagoon.
- Failure to inspect and maintain the dam.
- Liner integrity—protect from wave action, inlet pipe erosion, damage during sludge removal, or rupture from lowering lagoon liquid level below groundwater table.
- Rodent and tree damage to lagoon embankments.
- Modification of the lagoon structure—an example is the placement of a pipe in the dam without proper design, construction and/or installation. (Consult an expert in lagoon design before placing any pipes in dams.)

**Liquid Level Management**

Proper lagoon liquid level management should be a year-round priority. This task is especially important during extended rainy and wet periods so that problems are avoided.

Proper liquid level management requires the operator to:

- Maintain lagoon liquid level as close to the bottom of the temporary liquid storage volume as possible.
- Never pump the lagoon liquid level lower than the permanent storage level except to allow for excess rainfall during hurricane season. Provided the standards in the NRCS Guidance Document are met, lagoon levels may be lowered a maximum of 8 inches below the stop pump mark during the period of June 15 through October 31 (NRCS, NC, No. 359, February 2009).
- Never lower the lagoon liquid level below the seasonal groundwater table (see your system design or contact the local office of the Natural Resources Conservation Service for this level).

The lagoon liquid level must never be closer than the designed structural freeboard (generally 1 foot) plus the 25year, 24hour storm storage to the top of dike elevation, unless a storm larger than the 25year, 24hour storm has occurred. The top of dike elevation should be determined from the design as it relates to the permanent benchmark. If the dike wall has not settled, it can be measured from the lowest point of the dam or embankment. For
lagoons constructed after September 1, 1996, storage for the heavy rainfall factor must also be maintained.

Every effort should be made to maintain the lagoon close to the minimum liquid level as long as the weather, soil, and cropping conditions permit and in accordance with the waste management plan. Maximum storage capacity should be available in the lagoon for periods when the receiving crop is dormant (such as wintertime for bermudagrass) or when there are extended rainy spells such as the thunderstorm season in the summertime and during hurricane season.

Start irrigating at the earliest possible date in the spring based on nutrient requirements and soil moisture, and as allowed by the application windows specified in the CAWMP. Similarly, in the late summer/early fall the lagoon should be pumped down to the stop pump elevation (minimum temporary storage liquid level) (see Figure 5-1) to allow for winter storage.

Waiting until the lagoon has reached its maximum storage capacity before starting to irrigate does not leave room for storing excess water during extended wet periods. Overflow from the lagoon for any reason except a storm equal to or greater than a 25-year, 24-hour storm is a violation of state law and subject to enforcement action.

Note: Lagoon water should not be allowed to overtop dam. If lagoon water does overtop the dam, the moving water during overtopping will soon cause gullies to form in the dam. Once this damage starts, it can quickly cause a large discharge of wastewater and possible dam failure. A technical specialist’s or professional engineer’s advice should be sought for information on repair.

You should record the level of the lagoon just prior to when rain is predicted and then record the level again 4 to 6 hours after the rain (this assumes there is no pumping). This will give you an idea of how much your lagoon level will rise with a certain rainfall amount (you must also record your rainfall for this to work). Knowing this should help in planning irrigation applications and storage. If your lagoon rises excessively, you may have an inflow problem from a failing surface water diversion or there may be seepage into the lagoon from the surrounding soil.

**Other Management Guidelines**
- The more frequently and regularly that wastewater is added to a lagoon, the better the lagoon will function. Flush systems that wash waste into the lagoon several times daily are optimum for treatment. Pit recharge systems, in which one or more buildings are drained and recharged each day with all buildings being recharged once per week, also work well.
- Practice water conservation (water reuse)—minimize building water usage and spillage from leaking waterers, broken pipes, and washdown through proper maintenance and water conservation. This reduces fresh water consumption and reduces the volume of wastewater that ultimately must be stored in the lagoon and land-applied.
Minimize feed wastage and spillage by keeping feeders adjusted. This will reduce the amount of solids entering the lagoon. If a spill occurs, don’t wash feed into the lagoon. Remove and dispose of feed.

Locate float-pump intakes approximately 18 inches underneath the liquid surface and as far away from the drainpipe inlets and embankments as possible.

Prevent additions of bedding materials (wood chips, sawdust, etc.), long-stemmed forage or vegetation, moldy feed, plastic syringes, or other foreign materials from getting into the lagoon.

Frequently remove solids from catch basins at end of confinement houses or wherever they are installed.

**Surface Water Diversions**

Surface water diversion features are designed to carry all surface drainage waters (such as rainfall runoff, roof drainage, gutter outlets, and parking lot runoff) away from the lagoon and other waste treatment or storage structures. The only water that should be going in the lagoon is that which comes from flush system pipes and the rainfall that hits the lagoon directly.

The only exception to this is if you maintain animals or waste piles outside in such a manner that runoff from the concentrated animal area or waste area may enter surface waters. You should consult with a technical specialist to see what best management practices are needed for these situations. One possible practice is to catch the contaminated runoff water in the lagoon.

Inspect the diversion system for the following:

- Adequate vegetation
- Diversion capacity
- Ridge berm height

Identified problems should be corrected promptly. Inspect diversions during or immediately following a heavy rain to see if any surface water is getting into the building flush pits, pipes, or the lagoon. If technical assistance is needed to determine proper solutions, consult with appropriate experts.

**Lagoon Maintenance**

Routine inspection and maintenance of a lagoon is necessary to ensure the structure does not erode or otherwise allow the wastes to leak or discharge. At a minimum, the following items should be checked at least monthly:

- Lagoon surface—look for:
  - Undesirable vegetative growth
  - Floating or lodged debris
- Inadequate biological activity, signaled by a dark color, lack of bubbling, and excessive odor. Consultation with a technical specialist is recommended if these conditions occur for prolonged periods, especially during the warm season.
Lagoon liquid pH, which optimally should range from 7.0 to 8.0. Perform periodic checks. If the pH falls below 7.0, dose with agricultural lime at the rate of 1 pound per 1000 cubic feet of lagoon liquid volume and thoroughly mix until the pH rises above 7.0.

Embankment—look for:
- Settlement, cracking, or holes on embankment and around pipes
- Side slope stability—slumps or bulges
- Wet or damp areas on the back slope
- Erosion due to lack of vegetation or as a result of wave action
- Rodent damage
- Tree damage

Maintain a vegetative cover on the embankment to prevent erosion. Fescue, bahiagrass, or common bermudagrass are the most common vegetative covers. The vegetation should be maintained to allow for visual inspection of the lagoon dam and fertilized each year, if needed, to maintain a vigorous stand. The amount of fertilizer applied should be based on a soil test, but in the event that it is not practical to obtain a soil test each year, the lagoon embankment and surrounding areas should be fertilized with 800 pounds per acre of 10-10-10, or equivalent.

Brush and trees on the embankment must be controlled. This may be done by mowing, herbicide spraying, chopping, or a combination of these practices.

*Note: If the vegetation is controlled by spraying, the herbicide must not be allowed to enter the lagoon water. Such chemicals could harm the bacteria in the lagoon that are treating the waste. Consult the N.C. Agricultural Chemical Manual for recommended herbicides.*

Larger lagoons may be subject to liner damage due to wave action caused by strong winds. These waves can erode the lagoon sidewalls, thereby weakening the lagoon dam. Maintaining the waste liquid level near the stop pump elevation and keeping up a good stand of vegetation will reduce the potential damage caused by wave action. If wave action causes serious damage to a sidewall, inserting baffles or rip-rap in the lagoon may reduce the wave impacts.

Any of these problems could lead to erosion and weakening of the dam. If the lagoon has any of these problems, call an appropriate expert familiar with design and construction of waste lagoons. There is a resource list of experts in your area in Appendix D. A temporary fix may be needed if there is a threat of a waste discharge. However, a permanent solution should be reviewed by a professional engineer or technical specialist designated in structural design and installation. Any digging into a lagoon dam with heavy equipment is a serious undertaking with potentially serious consequences and should not be conducted unless recommended by an appropriate technical specialist.

Conduct a sludge survey annually and remove sludge from the lagoon either when the sludge storage capacity is full or the treatment volume has less than 50% of the total treatment volume as sludge and there is at least 2 ½ feet of liquid present at the intake.
pipe. See your waste plan for additional requirements. Obtain a certified sludge management plan prior to sludge removal. Sludge removal is discussed in more detail later in the chapter.

**Pump and Pipe Operation and Maintenance**

Pumping systems should be inspected and operated frequently. Pumping system maintenance should be done when the lagoon is at its low level. This will allow some safety time should major repairs be required. You should consider maintaining an inventory of spare parts or pumps.

Recognize that anytime wastewater is flowing, the potential for a discharge exists. Check for proper operation of:

- Recycle pumps
- Irrigation pumps
- All pipes and connections

Check for leaks, loose fittings, and overall pump operation. An unusually loud or grinding noise or a large amount of vibration may indicate that the pump is in need of repair or replacement. Follow manufacturers’ specifications for routine pump maintenance and record all maintenance and service performed on pumps in a logbook.

Breaks in piping are a common cause of discharges of animal waste. Frequent inspections of the piping system, including walking the areas where there are underground pipes, cannot be overemphasized. This should be done at least as frequently as you evaluate the lagoon level.

- Waste inlet pipes, recycling pipes, and overflow pipes—look for:
  - Separation of joints
  - Cracks or breaks
  - Accumulation of salts or minerals
  - Overall condition of pipes

As the operator, you should know where all pipes are located at your facility. You should make a map of your facility with all pipes clearly marked. The map should show the types of pipes, size, and the type of water each pipe carries (such as flush water, drinking water for animals, and drinking water for office). A color coded system for the pipes will help separate the types of pipes and their uses.

Extra repair pipes, fittings, and valves should be on hand in the event of a break. During repair of any pipe which carries waste, some temporary means must be used to ensure that all wastes and flush waters still reach the lagoon or holding pits. Commonly, a small dug trench is used for such temporary situations, being careful not to damage the lagoon liner. It is crucial to know where all pipes are so that repair equipment does not cause further pipe breakage.
Crystal Buildup in Recycle Lines

Struvite (magnesium ammonium phosphate) or similar crystalline material frequently occurs in lagoon liquid recycle pipes. This material develops in pumps and/or at joints of restriction and turbulence in the pipeline. The material starts as a soft scum that adheres to the pipes and pumps. However, once the material solidifies additional crystal growth can be rapid and can completely block even large pipes. There is no proven method of totally preventing these crystals.

To minimize difficulties associated with struvite the following should be considered:

- Use only smooth-walled plastic pipe.
- Minimize joints and elbows.
- Keep pipe flow velocities low enough to minimize excessive turbulence.
- Keep pipes and pumps as free of particulates as possible.
- Minimize suction lift on the pump.
- Ground the pump housings directly to prevent any stray voltage that could contribute to crystal growth.

Some producers have installed parallel piping systems that can be used to circulate acid. There are several acids (including muriatic or hydrochloric acid) that have been used somewhat successfully to decrease struvite buildup. Extreme caution must be exercised when handling acid. Eye protection and gloves should always be used. Diluted acid solutions should be placed in a plastic reservoir and a pump used to circulate the acid through the piping system until it is free of struvite. After one or more uses, the acid may lose its effectiveness depending on the amount of crystal to dissolve. The acid/salt solution should be disposed of properly by pumping it into the lagoon.

Sludge Management

Anaerobic lagoons will eventually develop a layer of sludge at the bottom during normal operation. Some individuals have experienced slower buildup of sludge using microbial or enzymatic additives. They appear to work on a case-by-case basis, and no specific recommendations are offered here.

The thickness of this layer must be monitored as required by your permit (typically annually unless an extension is granted by DWR). At the specified frequency, you must survey sludge depth in all lagoons at your farm. Design standards require that there be less than 50% of the total treatment volume as sludge and at least 2.5 feet of liquid present below the intake pipe. If these amounts are exceeded, a sludge Plan of Action must be completed. Appendix E gives an example of a sludge removal plan. Extension publication AG-639, Sludge Survey Methods for Anaerobic Lagoons (Appendix E), explains how to do a sludge survey.

Enough sludge must be removed to regain the minimum standard of sludge-free treatment volume. Sludge will have a drastically different nutrient content and must be sampled independently from the lagoon liquid. Once an assessment of the sludge volume and nutrient content is made, a technical specialist must revise the waste plan to allow for
land application to suitable sites at agronomic rates. Since lagoon sludge is typically high in phosphorus, copper, and zinc (all regulated nutrients) it is recommended that sludge be land-applied on fields that do not receive routine waste applications.

Sludge can be handled in a variety of ways. NC State Extension publication AG-604, *Sludge Management and Closure Procedures for Anaerobic Lagoons* (Appendix E), lists some methods that can be used for sludge removal.

**Sludge Removal**

Sludge accumulation is normally a gradual process in an anaerobic lagoon, but eventually it accumulates to a point where it must be removed. The rate of lagoon sludge buildup can be reduced by:

- Proper lagoon sizing
- Mechanical solids separation of flushed waste
- Gravity settling of flushed waste solids in an appropriately designed basin
- Minimizing feed wastage and spillage

When sludge must be removed, here are some removal techniques:

- Hire a custom applicator. It is your responsibility to make sure that both of you understand what the other is expected to do.
- When doing sludge/liquid removal through an irrigation system, first check with an irrigation specialist to be sure the equipment, including the pump, can handle the amount of solid material you plan on irrigating.
- Mix the sludge and lagoon liquid with a chopper-agitator impeller pump; pump through a large-bore sprinkler irrigation system onto nearby cropland.
- Dewater the upper part of lagoon by irrigation onto nearby cropland or forageland; mix remaining sludge; pump into liquid sludge applicator; haul and spread onto cropland or forageland and soil-incorporate.
- Dredge sludge with a dredge barge, haul and spread with manure spreader onto nearby cropland or forageland and soil-incorporate.
- Dewater, using polymers and geotextile tubes or bags to capture sludge in the tube and spread higher solids product onto cropland or forageland at a later time

Always consult the sludge management plan, waste management plan, farm conservation plan, or local Soil and Water Conservation district office to see if the specific fields used for sludge application can be disturbed with soil incorporation equipment. Regardless of the method used, have the sludge material analyzed for waste constituents just as you would the lagoon water. The sludge will contain different nutrient and metal values from the liquid. The application of the sludge to fields will be limited by these nutrients, as well as any previous waste applications to that field and crop requirement.

When removing sludge, pay attention to the liner to prevent damage. Close attention by the pumper or drag-line operator will ensure that the lagoon liner remains intact. If soil material or the synthetic liner material is being disturbed, stop the activity immediately and do not
resume until the sludge can be removed without liner injury. If the liner is damaged, it must be repaired as soon as possible.

Sludge removed from the lagoon has a much higher phosphorus and heavy metal content than lagoon liquid. Because of this, it should be applied to land with low phosphorus and metal levels, as indicated by a soil test, and incorporated to reduce the chance of erosion. Note that if the sludge is applied to fields with very high soil-test phosphorus, it should be applied only at rates equal to the crop removal of phosphorus (see Chapter 3).

As discussed in Chapter 3, it is highly recommended that sludge be applied only to fields that are not used for continual animal waste application to prevent phosphorus and persistent metal build-up that may render sites unsuitable for long-term waste application. If the sludge is to be applied on sprayfields already listed in the CAWMP, the operation’s overall PAN balance must include the additional PAN from the sludge and still remain in a PAN deficit for the animal operation.

The application of sludge will increase the amount of odor at the waste application site. Extra precaution should be used to observe the wind direction and other conditions that could increase the concern of neighbors. Injection or incorporation of sludge will help reduce odors.

Lagoon Closure
Until properly closed, a lagoon must be operated and maintained according to the waste system permit and the CAWMP, even if no animals are present, there is no additional manure input, and no waste application occurs. If the owner no longer wishes to maintain the lagoon, it is the owner’s responsibility to obtain and implement a lagoon closure plan to eliminate the possibility of a pollutant discharge. The owner must consult with the appropriate DWR regional office before closing an animal operation with a waste management system and lagoon closure must be performed under specified standards adopted by NRCS. A closure plan must include:

- An assessment of all of the nutrients remaining in the lagoon, including the sludge
- A proposed method of waste removal
- An amended waste utilization plan which specifies the fields, crops, and rates of nutrient application at agronomic rates
- Soil samples for any new fields to be added to the waste plan
- PLAT assessment, if required (see Chapter 3 for more on PLAT)

Appendix D contains the current NRCS standard (“Closure of Waste Impoundments,” Code 360) and related information concerning lagoon closures.

Irrigation System Operation
A thorough knowledge of the waste application system is needed to apply waste in accordance with the waste utilization plan. The operator must be familiar with such features as correct pressure settings, sprinkler spacing, travel speed, time of operation,
etc., to ensure the appropriate amount is uniformly applied. Operation of waste application systems is discussed in detail in Chapter 6.

**Innovative and New Management Practices**

There are several methods of improving or enhancing the handling and treatment of animal wastes. Many of these methods involve the separation of solids and liquids within the animal waste system. The producer may benefit through decreased costs in sludge and solids removal from lagoons, decreased nitrogen concentrations in wastewaters, and the increased flexibility in the land application of wastes depending on the enhancement method used.

**Solids Separation**

Removal of fresh solids from manure slurries and flush water will reduce the pollutant content of manure, prolong the life of storage structures, improve the effectiveness of biological treatment, and minimize odors. Beneficial uses of the recovered solids include bedding materials, animal feed supplements, composts, and soil amendments. Solids separation can be done with mechanical or gravity devices.

Mechanical separators of animal waste include: inclined screens, vibrating-screens, belt presses, and screw presses. Most mechanical separators require daily cleaning and flow adjustments. Screens will need to be replaced periodically when the solids removal is decreased.

A gravity settling basin may be less costly while removing 50 percent or more of the solids from liquid manure. Solids can be settled and filtered by a shallow basin (2 to 3 feet deep) with concrete floors and walls and a porous dam or perforated pipe outlet. Basins should allow access by a front-end loader to remove solids every 1 to 6 months.

The use of solid/liquid separators will improve the waste handling and treatment efficiencies of many livestock operations. With the removal of manure solids, the storage life of a structure will be increased and costs can be saved due to the lessened need for sludge removal. The buildup of phosphorus, copper, and zinc will be reduced. In some instances where lagoons are undersized or are not effectively treating waste, solids removal may reduce the waste load to a level where proper anaerobic treatment can occur. The buildup of solids in transfer pipes and pumps will also be reduced.

**Composting**

Composting stabilizes manure into a humus-like material. The opportunity exists for livestock producers to compost manure, separated manure solids, vegetative matter, or byproducts from other agricultural or nonagricultural sources. In some cases, composting may be a less expensive waste reduction process than alternative storage and treatment methods. The final composted product has less odor and breeds fewer flies than raw manure. The volume and weight is less than raw manure, thus requiring less cost to haul and spread the compost. Also, the heat generated by the composting process destroys pathogenic organisms and weed seeds in the manure.
Aerobic Treatment
The main advantages of aerobic (with oxygen) lagoons are (1) bacterial treatment tends to be more complete than anaerobic treatment and (2) the end products are relatively odorless. In naturally aerobic lagoons or oxidation ponds, oxygen needed for treatment diffuses across the water surface. Mechanically aerated lagoons combine the odor control advantages of aerobic digestion with relatively small surface area requirements. Aerators are used mainly to control odors in sensitive areas and nitrogen removal where land available for manure application is limited. A major limitation for mechanically aerated lagoons is the expense of continually operating electrically powered aerators. Aerobic lagoons also produce more sludge than anaerobic lagoons because more of the manure is converted to microbial biomass. Suitable land must be available to accept the sludge with its associated nutrients, although it may be possible to dewater this sludge (see above) and move the solids off the farm for application at other farms or for other treatment such as composting.

Multistage Lagoons
Two-stage lagoons have certain advantages over the typical single, primary lagoon. A two-stage anaerobic lagoon system has the same total liquid volume as a single primary lagoon. The first lagoon contains the design treatment volume and the sludge storage volume, while the second lagoon provides temporary storage prior to land application. A two-stage lagoon allows a maximum liquid level to be maintained in the primary lagoon for the most efficient stabilization of incoming wastes. The result is a more stable operation, which helps to minimize odors. More than two lagoons in series are rarely beneficial.

Pumping from a second-stage lagoon also reduces the solids pickup common to primary lagoons due to seasonal water turnovers, floating debris, and biological mixing. Because of the reduced solids, the second stage of a two-stage anaerobic lagoon system appears to have up to 25 percent less nitrogen in the lagoon liquid and up to 50 percent less phosphorus than a single primary lagoon with the same total volume. A second-stage lagoon, since it functions only as storage, may be pumped down completely. There only needs to be a maximum liquid level marker in this lagoon.

Disadvantages of multistage lagoons include:
- Increased surface area, which collects more rainfall
- Increased construction cost

Odor Control Products
A number of commercial products have been marketed that advertise the ability to either reduce or control odors. These materials include: (1) masking agents, (2) chemicals that can temporarily bind ammonia, (3) chemicals that inhibit ammonia production, (4) chemicals that neutralize odor, (5) chemicals that stimulate bacterial growth, and (6) bacterial preparations that contain “special” strains of bacteria. However, most of these products have not been scientifically evaluated and proven to be effective. Nonetheless, there are numerous
reports from producers attesting to the partial effectiveness of some of these products. A livestock producer should be very wary of any unsupported claims by vendors of “odor control” products. Chemicals that may have positive results in one situation may not be effective in seemingly similar situations.

**Review Questions**

1. Name the six design volumes for an anaerobic lagoon.

2. Describe some common types of lagoon liners.

3. Explain when and why you should pump lagoon wastewater to cropland.

4. Name several causes of lagoon failures.

5. List several ways in which you may be able to reduce the amount of solids entering an anaerobic lagoon.

6. Name some advantages and disadvantages of the following types of waste application equipment:
   
   a. stationary big guns;

   b. traveling systems; and

   c. pump and haul (honey wagon).

7. Describe how sludge is to be monitored and handled in a waste management system.
Certification Training for Operators of Animal Waste Management Systems
Proper waste application involves knowledge of the waste application system, the soils and crops, and the required setbacks that must be adhered to. This chapter will explain the required setbacks and all other factors that must be considered when you are trying to determine when and how much to apply.

**Setbacks**

Setbacks are intended to prevent animal operations from causing surface or groundwater contamination or creating nuisance conditions such as drift, odor, dust, and insect problems at neighboring properties. A setback is the minimum separation distance (in feet) between application areas and physical features such as buildings, wells, property lines, or perennial streams/rivers. A “perennial stream/river” means a well-defined channel that contains water year round in a normal rainfall year, and can be identified as indicated by a solid blue line on a United States Geological Survey topographic map.

There are several setbacks that must be adhered to when land applying animal waste. The first are those that are required by law.

All operations that meet the threshold number of animals and are required to have a permit (including swine farms sited or expanded before September 30, 1995) must meet the setback requirements in Table 6-1. The outer perimeter of the waste application area cannot be closer than the distances listed.

**Table 6-1. Minimum setback distances for waste application areas that all permitted animal operations must meet.**

<table>
<thead>
<tr>
<th>Physical feature</th>
<th>Minimum distance from feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perennial water</td>
<td>25 feet of vegetated buffer</td>
</tr>
<tr>
<td>Dwelling not owned by the producer</td>
<td>200 feet</td>
</tr>
<tr>
<td>Well</td>
<td>100 feet</td>
</tr>
</tbody>
</table>

Swine operations must meet additional setbacks for waste application areas depending on:

- the permit type;
- the date of facility siting; and/or
- the date the waste application field was placed in use.

Swine farms sited on or after October 1, 1995 and constructed or expanded before August 27, 1997 must meet the setbacks listed in Tables 6-1 and 6-2.
Table 6-2. Additional setback distances for waste application areas at swine operations sited on or after October 1, 1995 and constructed or expanded before August 27, 1997.

<table>
<thead>
<tr>
<th>Physical feature</th>
<th>Minimum distance from feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perennial stream/river other than a ditch or canal</td>
<td>50 feet</td>
</tr>
<tr>
<td>Residential property boundary</td>
<td>50 feet</td>
</tr>
</tbody>
</table>

Swine farms sited or expanded after August 27, 1997, must meet the setbacks listed in Table 6-1 and the setbacks in Table 6-3.

Table 6-3. Additional setback distances from waste application areas for swine operations sited and constructed or expanded after August 27, 1997.

<table>
<thead>
<tr>
<th>Physical feature</th>
<th>Minimum distance from feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perennial stream/river other than a ditch or canal</td>
<td>75 feet</td>
</tr>
<tr>
<td>Residential property boundary</td>
<td>75 feet</td>
</tr>
</tbody>
</table>

Regardless of facility siting date, a swine farm must meet the 75-foot requirements in Table 6-3 for any new waste application field put in use after August 27, 1997 that:

a. was not within the property boundary where the waste was generated; or
b. was not within the property boundary where waste was previously applied from the operation.

Other new waste application fields within the property boundary where the waste is generated or on which waste has previously been applied are not required to meet the 75-foot setbacks in Table 6-3, but must meet the requirements in Tables 6-1 and 6-2.

Swine operations sited on or after October 1, 1995 also have setback requirements for production houses and lagoons. Houses and lagoons cannot be located within the 100-year floodplain and must meet the minimum separation distances from the features listed in Table 6-4.
Table 6-4. Setbacks for production houses and lagoons for swine operations sited on or after October 31, 1995.

<table>
<thead>
<tr>
<th>Physical feature</th>
<th>Minimum distance from feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perennial streams/rivers other than a ditch or canal</td>
<td>100 feet</td>
</tr>
<tr>
<td>Water supply wells</td>
<td>500 feet&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Property boundaries</td>
<td>500 feet&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Occupied residences</td>
<td>1,500 feet&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Schools, hospitals, churches, childcare centers, outdoor recreational facilities, national or state parks, or historic properties</td>
<td>2,500 feet&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup> Does not apply to a well located on the same tract of land as the swine house or lagoon and that supplies water only for use on that tract of land or for the use on adjacent tracts of land all of which are under common ownership or control.

<sup>2</sup> May be located closer if written permission is given by the owner of the property and recorded with the Register of Deeds.

You should also review your waste management plan or permit to see if any additional setbacks are required. Remember, the requirements in Tables 6-2, 6-3, and 6-4 are for swine operations only.

The last setback is a “good neighbor” setback. Do not land apply on days with excessive wind. Drift on these days may impact neighbors or pollute surface waters.

Describe why wind speed and direction should be considered when irrigating.
Figure 6-1. Nutrient management and irrigation scheduling decision-making flowchart.
**Irrigation Scheduling**

Proper land application of lagoon liquid involves the use of water management strategies to best achieve a balance between:

- Optimizing the timing of nutrient application with crop uptake and growth.
- Maintaining adequate storage in the lagoon to handle extreme rainfall events without overtopping.
- Applying lagoon liquid at a rate and amount such that no direct surface runoff or deep percolation below the root zone occurs on the application site.

A responsible system operator must understand how his/her wastewater should be managed, have knowledge of the capacity of his/her system to store and apply wastewater when appropriate, and be able to make prudent management decisions concerning when and how much wastewater to land-apply. For a liquid waste management system utilizing irrigation, this decision-making process is called **irrigation scheduling** and is generally based on the flowchart in Figure 6-1.

**Determining When to Irrigate**

Four basic questions should be answered when deciding to irrigate:

1. Do I have an actively growing crop, or will a crop be planted or begin active growth within 30 days?
2. Is the liquid level in my lagoon above the minimum storage depth?
3. Do I have a nitrogen deficit remaining for this crop cycle?
4. Are my land application fields dry enough to be irrigated?

If the answer to all four questions above is yes, then you should schedule irrigation. The answer to Questions 1, 2, and 3 are straightforward and should be easy to determine. Question 3 requires knowledge of the quantity of nutrients you can apply and how much has already been applied. This was discussed in Chapter 3 and is found in the waste utilization plan. Record keeping will be addressed further in Chapter 7. The next section will discuss how to determine soil-water content and how to determine irrigation rates (Question 4).

Land application of waste shall cease within four (4) hours of the time that the National Weather Service issues a Hurricane Warning, Tropical Storm Warning, or a Flood Watch associated with a tropical system including a hurricane, tropical storm, or tropical depression for the county in which the permitted facility is located.

**Estimating Soil-Water Content**

Determining whether or not the field is “dry” enough to be irrigated is not always obvious. There are three practical ways to tell:

1. A subjective method that involves “feeling” the soil
2. Objective methods utilizing soil-moisture measuring devices
3. An accounting approach (checkbook method)
One of these three methods should be used to estimate the amount of water present in the soil before irrigation begins.

**Feel Method**
The feel method involves actually feeling the soil with your hand. This method is easy to use and many growers schedule irrigation in this way. This method is “subjective” since the results depend on the experience of the person doing the measurement. Some guidelines for estimating soilwater content by the feel method are given in Table 6-5.

**Table 6-5. “Feel” guidelines for Estimating the Amount of Plant-Available Water to Be Replaced with Wastewater Irrigation as a Function of Soil Texture**

<table>
<thead>
<tr>
<th>Available Water Remaining in the Soil</th>
<th>Sands Loamy Sand</th>
<th>Sandy Loam</th>
<th>Clay, Clay Loam, Sandy Clay Loam</th>
<th>All Other Textures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maximum Recommended Wastewater Irrigation (per foot of effective root zone depth)</td>
<td></td>
</tr>
<tr>
<td>100% (i.e., field capacity)</td>
<td>When ball is squeezed, no free water appears on soil but wet outline of ball is left in hand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wastewater Irrigation</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>75% to 100%</td>
<td>Sticks together only slightly</td>
<td>Forms a ball that breaks easily</td>
<td>Forms a ball; very pliable</td>
<td>Easily ribbons between thumb and forefinger; feels slick</td>
</tr>
<tr>
<td>Wastewater Irrigation</td>
<td>0.1 to 0.2 inch</td>
<td>0.2 to 0.3 inch</td>
<td>0.2 to 0.4 inch</td>
<td>0.2 to 0.4 inch</td>
</tr>
<tr>
<td>50% to 75%</td>
<td>Appears dry, will not form a ball</td>
<td>Forms weak ball which falls apart</td>
<td>Forms ball; slightly plastic; slightly slick</td>
<td>Forms ball; forms ribbon</td>
</tr>
<tr>
<td>Wastewater Irrigation</td>
<td>0.2 to 0.3 inch</td>
<td>0.3 to 0.4 inch</td>
<td>0.3 to 0.5 inch</td>
<td>0.3 to 0.6 inch</td>
</tr>
<tr>
<td>25% to 50%</td>
<td>Appears dry, will not form a ball</td>
<td>Appears dry, will not form a ball</td>
<td>Somewhat crumbly but holds under pressure</td>
<td>Forms ball under pressure; somewhat pliable</td>
</tr>
<tr>
<td>Wastewater Irrigation</td>
<td>0.3 to 0.5 inch</td>
<td>0.3 to 0.6 inch</td>
<td>0.3 to 0.6 inch</td>
<td>0.3 to 0.7 inch</td>
</tr>
<tr>
<td>0 to 25%</td>
<td>Dry, loose, single-grained, flows through fingers</td>
<td>Dry, loose, flows through fingers</td>
<td>Powdery, dry; easily breaks into powdery condition</td>
<td>Hard, cracked; may have loose crumbs on soil surface</td>
</tr>
<tr>
<td>Wastewater Irrigation</td>
<td>0.3 to 0.5 inch</td>
<td>0.3 to 0.6 inch</td>
<td>0.3 to 0.7 inch</td>
<td>0.3 to 0.7 inch</td>
</tr>
</tbody>
</table>

**Measuring Devices**
Devices for measuring soil water include the gravitational method, tensiometer, electrical resistance blocks, neutron probe, Phene cell, and time domain reflectometer. These methods differ in reliability, cost, and labor intensity.
Tensiometer and electrical resistance blocks are the most cost-effective and reliable devices for on-farm measurement of soil-water for irrigation in North Carolina. Tensiometers are best suited for sandy, sandy loam, and loamy soil textures, while electrical resistance blocks work best in silty or clayey soils. Manufacturers of these devices provide calibration charts and recommended ranges for traditional “fresh” water irrigation. You should be aware that the calibration curves and recommendations supplied by the manufacturer for these devices were developed for general conditions and are not adequate for specific soil conditions and fields. You should also be aware that wastewater objectives and recommendations are different from fresh water recommendations. For irrigating wastewater, you will get better results if all soil-water measuring devices you use are calibrated for the major soils you are irrigating.

**Checkbook Method**
The checkbook method is an accounting approach for estimating how much soil-water remains in the effective root zone based on water inputs and outputs. It is much like keeping track of the daily balance on a bank account by monitoring deposits and withdrawals. Wastewater irrigation is scheduled when the soil-water content in the root zone drops below a threshold level. Some of the simpler checkbook methods keep track of rainfall, evapotranspiration, and irrigation amounts. More sophisticated methods require periodic measurements of the soil-water status and moisture use rates of the crop.

Checkbook methods require detailed daily record keeping, which can become time consuming for the more complex methods. One of the advantages of the checkbook approach is that it can be managed using a computer program. Computer programs have been developed to handle the accounting and provide timely and precise scheduling recommendations. Because this method can become very complex, requiring much data input, it will not be discussed further in this manual. See NC State Extension publication AG-607, *Irrigation Scheduling to Achieve Proper Application of Wastewater*, for further information.

**Determining How Much to Irrigate**
Irrigation should be scheduled and timed so that:

- No surface runoff occurs during irrigation
- The root zone is not completely saturated at the conclusion of irrigation
- The irrigated water does not leach below the root zone

Your CAWMP should have maximum limits of how much wastewater can be applied per hour or per event. You must never exceed these amounts, but you may apply less than these amounts. Using these numbers in the plan as a maximum, the amount of wastewater that can or should be applied during any single irrigation cycle is dictated by how much water the soil can “soak up.” This varies from day to day and is influenced by:

- **Rainfall**—when and how much it last rained
- **Crop maturity**—water uptake rate of the crop
- **Soil type**—texture, structure, depth, and cover
- **Effective root depth**—dependent on soil characteristics and crop type and age
- **Evapotranspiration**—influenced by temperature, wind, and relative humidity
No more than 1.0 inch can be applied per 24-hour period.

There are many chances to apply wastewater during the year at reduced rates (below the maximum allowable) that still allow the operator to manage the lagoon level. Based on the factors above, decisions can be made to apply wastewater at many times of the year to allow for lagoon level management. Some of these applications will be lighter to ensure that overapplication (ponding, runoff) does not occur. Once you make a determination on how much wastewater to apply, set your equipment accordingly to deliver that amount. Equipment details and settings will be covered in the next section.

Regardless of the calculated rate, you as the system operator should monitor each waste application to verify adequate infiltration of the waste into the soil. An irrigation cycle should be stopped if ponding and runoff start to occur.

Operational Considerations

A key component of the irrigation design is to select the proper combination of system components so that the system precipitation rate does not exceed the infiltration rate of the soil. Several terms may be used to express the rate at which water is being applied to a field during irrigation. Terms you should be familiar with include: discharge rate, precipitation rate, and application volume.

Discharge Rate

Discharge rate is the volume of water exiting a sprinkler per unit of time and is normally expressed in terms of gallons per minute (gpm). Discharge rate can also be referred to as “sprinkler flow rate”. Manufacturers publish discharge rates for their sprinklers as a function of operating pressure and orifice diameter of the nozzle. You should always have a copy of the manufacturer’s discharge specifications for the sprinklers on your system. Discharge characteristics for three typical sprinklers used for wastewater irrigation are given in Table 6-6. For example, a Rainbird Model 70 sprinkler operated at 55 psi (pounds per square inch) with a 9/32-inch diameter nozzle has a discharge rate of 17.2 gpm.

Discharge characteristics for typical big guns are shown in Table 6-7. For contrast, notice how much higher discharge rates are for gun sprinklers than for rotary impact sprinklers.

Table 6-6. Discharge Characteristics for Rotary Impact Sprinklers Used with Permanent Stationary Irrigation System

<table>
<thead>
<tr>
<th>Nozzle Size (inch)</th>
<th>Operating Pressure (PSI)</th>
<th>50</th>
<th>55</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Flow GPM</td>
<td>Diameter FT</td>
<td>Flow GPM</td>
</tr>
<tr>
<td>Nelson F70APV</td>
<td></td>
<td>12.8</td>
<td>128</td>
<td>13.6</td>
</tr>
<tr>
<td>1/4</td>
<td></td>
<td>16.0</td>
<td>134</td>
<td>16.8</td>
</tr>
<tr>
<td>9/32</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rain Bird 70 CWH</td>
<td></td>
<td>12.9</td>
<td>124</td>
<td>13.6</td>
</tr>
<tr>
<td>1/4</td>
<td></td>
<td>16.3</td>
<td>131</td>
<td>17.2</td>
</tr>
<tr>
<td>9/32</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Define discharge rate, precipitation rate, and application volume.

Explain how to obtain sprinkler discharge rates.

Explain how/why irrigation amounts need to be adjusted seasonally.
### Table 6-6. Discharge Characteristics for Rotary Impact Sprinklers Used with Permanent Stationary Irrigation System (continued)

<table>
<thead>
<tr>
<th>Nozzle Size (inch)</th>
<th>Operating Pressure (PSI)</th>
<th>Flow GPM</th>
<th>Diameter FT</th>
<th>Flow GPM</th>
<th>Diameter FT</th>
<th>Flow GPM</th>
<th>Diameter FT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50</td>
<td></td>
<td></td>
<td>55</td>
<td></td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Senniger 7025 RD-1-DFF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/4</td>
<td></td>
<td>13.0</td>
<td>127</td>
<td>13.6</td>
<td>131</td>
<td>14.2</td>
<td>138</td>
</tr>
<tr>
<td>9/32</td>
<td></td>
<td>16.3</td>
<td>133</td>
<td>17.1</td>
<td>137</td>
<td>17.8</td>
<td>142</td>
</tr>
</tbody>
</table>

### Table 6-7. General Flow Rates and Coverage Diameter for Big Gun Sprinklers.

#### Taper Bore Nozzle

<table>
<thead>
<tr>
<th>Gun Model</th>
<th>Pressure (PSI)</th>
<th>Nozzle Diameter (inch)</th>
<th>GPM</th>
<th>DIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>100T</td>
<td>0.5</td>
<td></td>
<td>50</td>
<td>205</td>
</tr>
<tr>
<td></td>
<td>0.75</td>
<td></td>
<td>115</td>
<td>260</td>
</tr>
<tr>
<td>150T</td>
<td>1.0</td>
<td></td>
<td>205</td>
<td>310</td>
</tr>
<tr>
<td>150T</td>
<td>1.5</td>
<td></td>
<td>515</td>
<td>340</td>
</tr>
<tr>
<td>200T</td>
<td>2.00</td>
<td></td>
<td>912</td>
<td>430</td>
</tr>
</tbody>
</table>

#### Ring Type Nozzle

<table>
<thead>
<tr>
<th>Gun Model</th>
<th>Pressure (PSI)</th>
<th>Nozzle Diameter (inch)</th>
<th>GPM</th>
<th>DIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>100R</td>
<td>0.71</td>
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<td>74</td>
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<td>81</td>
<td>235</td>
</tr>
<tr>
<td>150R</td>
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<td></td>
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<td>245</td>
</tr>
<tr>
<td>150R</td>
<td>1.56</td>
<td></td>
<td>94</td>
<td>255</td>
</tr>
<tr>
<td>200R</td>
<td>2.00</td>
<td></td>
<td>99</td>
<td>265</td>
</tr>
</tbody>
</table>

Explain how to obtain sprinkler discharge rates.

Explain what effect changing nozzle diameter can have on discharge rate and wetted diameter.
**Precipitation Rate and Application Volume**

Precipitation rate is normally expressed as unit depth of water (inches) per unit of time (usually an hour). The precipitation rate (inches per hour) depends upon discharge rate and coverage diameter. Another important concept is total application volume (also expressed as application depth in inches), which is computed based on the amount of time the system operates at a given rate on a given field. For example, you might typically irrigate ½ inch (0.5 inch) per irrigation cycle.

Wastewater analyses are expressed in terms of pounds of plant-available nitrogen (lb PAN) per 1,000 gallons of wastewater. When irrigating, it is preferable to express irrigation amounts as an equivalent depth of water, for example, 1/2 inch per acre. Therefore, it is often necessary to convert between application volume expressed as gallons per acre and application volume expressed as an inches per acre (or acre-inches). **One inch of water spread over an acre, referred to as acre-inch, is equal to 27,154 gallons.**

**Example:**

If you apply 0.5 inches of irrigation water, how many gallons per acre will be applied?

**Solution:**

\[
27,154 \text{ gal/acre-inch} \times 0.5 \text{ inches} = 13,577 \text{ gal/acre}
\]

Note: Most irrigation systems do not completely cover a field with wastewater during operation. For example, a 30-acre pasture may only receive wastewater application on 23 acres due to the layout of the field, setbacks that must be observed, and operational parameters of the irrigation system. A wastewater application design and the appropriate records must reflect the area, which receives wastewater, in this case 23 acres as opposed to the total field size. The 23 acres in this scenario are referred to as wettable acres. Depending on when your waste plan was written, revised, or when an irrigation system upgrade occurred, you may have had a wettable acres determination done on your farm. This determination must be performed by a technical specialist with special training in irrigation systems.

To attain acceptable application uniformity, stationary sprinklers are typically arranged in a square pattern at a spacing of 50 to 65 percent of the wetted diameter. A typical layout for stationary sprinklers is shown in Figure 6-2. The orifice size, sprinkler spacing, and operating pressure are selected from manufacturer’s literature to achieve the desired overlap and uniformity of coverage.
**Determination of Precipitation Rates for Stationary Sprinklers**

The precipitation rate for stationary sprinklers is computed from the formula:

\[
\text{Precipitation rate (in/hr)} = \frac{96.3 \times \text{sprinkler flow rate (gpm)}}{\text{sprinkler spacing (ft)} \times \text{lateral spacing (ft)}}
\]

**Procedure for computing precipitation rate:**

1. Determine the discharge rate (sprinkler flow rate) and wetted diameter from manufacturer’s literature.

   **Example:** From Table 6-2, RainBird Model 70 with a 9/32-inch diameter nozzle operated at 55 psi:

   \[
   \text{Sprinkler flow rate} = 17.2 \text{ gpm} \\
   \text{Wetted Diameter} = 133 \text{ feet}
   \]

2. Recommended sprinkler spacing is 50 to 65 percent of wetted diameter. Using a value of 60 percent:

   \[
   \text{Design sprinkler spacing} = 0.6 \times 133 \text{ ft} = 79.8 \text{ ft}
   \]

Sprinklers are normally spaced in equal multiples of 20 feet based on typical pipe length. Therefore, the design spacing would be 80 feet: for example, the sprinkler spacing along the lateral would be 80 feet and the lateral spacing would be 80 feet such that the effective area of a sprinkler would be 80 feet by 80 feet.
3. Precipitation rate is then computed as:

\[
\text{Precipitation rate (in/hr)} = \frac{96.3 \times 17.2 \text{ gpm}}{80 \times 80 \text{ ft}} = 0.26 \text{ in/hr}
\]

The *application volume* is then computed as the precipitation rate multiplied by the operating time. In most cases, you will estimate the desired application volume based on soil conditions as described earlier. If this is the case, you then compute the time required to operate the system to achieve the desired application volume. For example, if the desired application volume is 0.6 inch, then the required operating time for the system would be:

4. Compute the time of operation:

\[
\text{Time of operation (hr)} = \frac{\text{application volume (in)}}{\text{precipitation (application) rate (in/hr)}}
\]

So:

\[
\text{Time of operation (hr)} = \frac{0.6 \text{ in}}{0.26 \text{ in/hr}} = 2.3 \text{ hr}
\]

**Determination of Precipitation Rates for Traveling Gun Sprinklers**

The precipitation rate in inches per hour for a traveling gun sprinkler is generally not affected by travel speed. This situation occurs because at any given position within the wetted diameter, water is usually being applied for at least an hour or longer. The precipitation rate *is* affected by the angle of rotation of the gun sprinkler. For example, if the gun only makes a half circle (180 degrees of rotation), the precipitation rate is twice that of a gun making a full circle (360 degrees of rotation).

**Determination of Application Volume (Depth) for a Traveling Gun Sprinkler**

The volume of wastewater applied by a traveling gun depends on the flow rate, lane spacing, and travel speed. The travel lane spacing should be approximately 70 to 80 percent of the sprinkler’s wetted diameter as shown in Figure 6-3. The application volume is computed by the formula:

\[
\text{Application volume (in)} = \frac{19.3 \times \text{ sprinkler flow rate (gpm)}}{\text{lane spacing (ft)} \times \text{ travel speed (in/min)}}
\]

**Example:**

What is the application volume for a gun sprinkler if the operating pressure is 80 psi, the taper bore nozzle diameter is 1.0 inch, and the travel speed is 3 feet per minute?

From Table 6-3, for a gun sprinkler operated at 80 psi with a 1.0-inch nozzle, the discharge rate is 260 gpm and the wetted diameter is 355 feet.

If the lane spacing is 75 percent of the wetted diameter, the lane spacing is:

\[
0.75 \times 355 \text{ ft} = 266 \text{ ft}
\]
The travel speed needs to be expressed in inches per minute. A travel speed of 3 feet per minute is equal to 36 inches per minute.

\[ 3 \text{ ft/min} \times 12 \text{ in./ft} = 36 \text{ in./min} \]

The application volume is then computed to be:

\[ \text{Application volume (in)} = \frac{19.3 \times 260 \text{ gpm}}{266 \text{ ft} \times 36 \text{ in/min}} = 0.52 \text{ in} \]

![Diagram of a traveling gun irrigation system with typical layout and lane spacing.](image)

**Figure 6-3. Typical layout of a traveling gun irrigation system. Lane spacing is typically 70 to 80 percent of wetted diameter.**

**Determination of Travel Speed for a Traveling Gun Sprinkler**

During typical operation, you select an application depth based on the soil and site conditions. Most manufacturers’ charts will show how to select a travel speed to do this. It can also be computed by the following formula:

\[ \text{Travel speed (in/min)} = \frac{19.3 \times \text{sprinkler flow rate (gpm)}}{\text{lane spacing (ft)} \times \text{application volume (in)}} \]

**Example:**

What travel speed is necessary to apply 0.6 inch with a gun sprinkler if the operating pressure is 80 psi and the taper bore nozzle diameter is 1.0-inch?

From Table 6-3, for a gun sprinkler operated at 80 psi with a 1.0-inch nozzle, the discharge rate is 260 gpm and the wetted diameter is 355 feet.

If the lane spacing is 75 percent of the wetted diameter, the lane spacing is:

\[ 0.75 \times 355 \text{ ft} = 266 \text{ ft} \]

\[ \text{Travel speed (in/min)} = \frac{19.3 \times 260 \text{ gpm}}{266 \text{ ft} \times 0.6 \text{ in}} = 31.4 \text{ in/min} \]
**System Changes**

Before making any changes to your application equipment, including settings for travel speed or changing of nozzles, consult your waste management plan to see if there are specifications that must be adhered to. What may appear to be minor changes, such as a nozzle or ring size, can have significant effects on the discharge rate and wetted diameter of a sprinkler. Minimally, a change in application equipment type will require re-calibration of the irrigation system.

Operating the system differently than directed in the design will alter the application rate, diameter of coverage, and subsequently the application uniformity. For example, operating the system with excessive pressure results in smaller droplets, greater potential for drift, and accelerated wear of the sprinkler nozzle. Clogging of nozzles can result in pressure increase. Plugged intakes or crystallization of mainlines will reduce operating pressure. Operating below design pressure greatly reduces the coverage diameter and application uniformity.

**Part-turn Sprinklers**

Part-turn sprinklers are sometimes used to gain wettable area where a full turn sprinkler may result in an encroachment on a required setback or field ditch. Caution must be exercised when operating part-turn sprinklers, as the discharge area is much less than that with a full turn sprinkler. If designed properly so that the flow from a part-turn sprinkler is less than neighboring full-turn sprinklers in the same field, then a consistent application rate may be achieved. Otherwise, it could be that the operator must manually limit the run time on part-turn sprinklers by way of a valve on the individual sprinkler risers or with a field valve at the system header. This same philosophy also applies to gun angle on a traveling big gun. Many operators will set the gun angle at less than 360 degrees in order to not wet the hose reel. A smaller gun angle results in an increased precipitation rate. The operator should be aware of this situation and closely monitor the infiltration of the applied wastewater.

**Managing Irrigation Systems**

The operator of a waste management system must develop a consistent method of record-keeping when it comes to irrigation system management. All waste applications must be recorded on approved record-keeping forms (Chapter 7). Records must reflect the actual area (wetted area) being irrigated along with run times for each irrigation cycle. Because of this, most operators find it easier to set up each irrigation field zone or hydrant as a separate field when it comes to maintaining records. Unless a field is managed consistently throughout the year with respect to waste applications, the zone or hydrant methods seem to work the best. If an operator chooses to keep records by field, then consistency with irrigation run times and/or travel speeds must be maintained throughout the field to ensure that the waste is being applied uniformly to the entire field.

When using each individual hydrant as a field (often referred to as a “pull”), the operator should establish field markers to ensure that each pull of the gun cart is consistent and to provide proper irrigation overlap between lanes.
**System Calibration**

Information presented in manufacturer’s charts is based on average operating conditions with relatively new equipment. Discharge rates and application rates change over time as equipment gets older and components wear. In particular, pump wear tends to reduce operating pressure and flow. With continued use, nozzle wear results in an increase in the nozzle opening, which will increase the discharge rate while decreasing the pressure and wetted diameter.

For these reasons, all waste application equipment, including irrigation systems, hose-drag systems, honey wagons, and solid spreaders must be field tested and calibrated to verify operating performance and application amount. Field calibration to verify application amount is required once a year for NPDES permitted facilities and once every other year for state permitted operations.

Calibration of irrigation systems involves field verification of (1) operating pressure; (2) wetted diameter; (3) flow rate; and (4) application uniformity.

Minimum calibration performance requirements are:

1. Operating pressure at the sprinkler/gun must be verified using a properly functioning pressure gauge and observed to be operating within the range recommended by the manufacturer or specified in the irrigation design documentation for the equipment being calibrated.

2. Wetted diameter of the system being field calibrated must be measured as described in NC State Extension *Irrigated Acreage Determination* publications AG-553-6 or AG-553-7 and observed to be within 15% of the wetted diameter reported in the manufacturer’s chart for the operating pressure observed in Item 1.

3. Flow rate must be determined to be within 10% of the value specified in the irrigation design documentation or as was determined during the wettable/effective irrigated acre determination. Flow rate shall be determined using either:
   a. flow rate from manufacturer’s chart for the measured pressure at the sprinkler/gun (Item 1) and measured sprinkler/gun orifice diameter and type; or
   b. flow rate measured with an approved, calibrated flow meter.

4. Application uniformity is deemed to be acceptable when Items 1 through 3 above are within the ranges specified.

Rain gauges or other containers can be used to check uniformity but not to measure flow of a system. Pans, plastic buckets, jars, or anything with a uniform opening and cross-section can be used provided the liquid collected can be easily transferred to a scaled container for measuring.

Calibration workbooks for various types of waste application systems can be obtained from your local Cooperative Extension office.
Pump-and-Haul Waste Management Systems

Wastes that have a higher solids content that can’t easily be handled through an irrigation system may require land application through a pump and haul system. Typically, wastes or slurries with solids concentrations above 3 to 4 percent are difficult to handle as a liquid and cause excessive wear and clogging to standard irrigation pumps and equipment. Liquid applicators and tank spreaders are an alternative to irrigation for applying these materials.

Many of the decisions on when and how much to irrigate wastewater are determined by the liquid nature of the waste and the potential for runoff. With slurry or solids application, these decisions surrounding liquid application are not as critical. Certainly, it is still your job as the system operator to ensure that the applied waste will not run off the property, but the solid nature of the wastes greatly reduces the tendency of these materials to run. Therefore, the decision process for waste application is more related to the stage of crop growth and whether the crops need nutrient applications. Another important issue is the “trafficability” of the fields or how easily your equipment can be operated to obtain uniform waste application without rutting the field or causing soil compaction. Once the decision has been made to perform waste application, you must be aware of your equipment’s waste application rate. This requires the calibration of the land application equipment.

A certain percentage of the nutrients in slurry and solid manures is tied up in the organic portion of the waste and is not immediately available for plant uptake. These nutrients will slowly become available to plants over the course of several months to years. To satisfy your waste management plan, you are only required to keep track of the nutrients that are available for the first crop. It is possible, but tedious, to develop a system to determine the “carryover” nutrients from the organic portion of the manure. It is beyond the scope of this training to do this exercise and as mentioned it is not required at this time. However, you may wish to consider this issue to help minimize the potential for overapplication of nutrients (especially nitrogen) that may be detrimental to your crops, soils, or groundwater.

Liquid Manure Spreaders

Manure spreaders are an alternative to irrigation for applying liquid manure. They may be the only option when manure slurry is too thick to be irrigated, as may be the case with dairy slurry or swine lagoon sludge, where solids content ranges from 3 to 12 percent. Spreader options include a liquid tanker, which is truck mounted or pulled behind a tractor, or a hose-drag type of system which is connected by piping or an irrigation reel directly to the lagoon (or waste storage pond) pump. Both systems require an operator to drive the machine. Also, fields must be dry enough and firm enough to handle the heavy machinery.

Hose-drag systems have an advantage over tankers in that the wastewater or slurry is constantly being supplied to the machine as opposed to having to reload a tanker by repeated trips to the lagoon or waste storage pond. The hose-drag system allows for higher pumping volumes when waste application conditions are suitable.
Liquid tank spreaders must be accurately calibrated to apply wastes at proper rates. Calibration is the combination of settings and travel speed needed to apply wastes at a desired rate and to ensure uniform application. To calibrate, you must know the spreader capacity, which is normally rated by the manufacturer in gallons.

**Calibration method:**
1. Spread at least one full load of waste, preferably in a square or rectangular pattern for ease of measuring, with normal overlaps.
2. Measure the length and width of coverage, recognizing that the outer fringe areas of the coverage will receive much lighter applications than the overlapped areas.
3. Multiply the length by the width and divide by 43,560 to determine the coverage area in acres.

\[
\text{Coverage area (area of rectangle in ft}^2) = \text{length (ft)} \times \text{width (ft)}
\]

\[
\text{Coverage area (acres)} = \frac{\text{length (ft)} \times \text{width (ft)}}{43,560 \text{ ft}^2/\text{acre}}
\]

4. Divide the gallons of wastewater in the spreader by the acres covered to determine the application rate in gallons per acre.

\[
\text{Application rate for spreader (gal/acre)} = \frac{\text{spreader load volume (gal)}}{\text{coverage area (acres)}}
\]

Repeat the procedure at different speeds and/or spreader settings until the desired application rate is achieved.

Once you have performed the calibration, it is good to note what gear settings and engine rpms correlates to a certain application rate. A simple table may be made as follows:

<table>
<thead>
<tr>
<th>Tractor Gear</th>
<th>Engine speed (rpm)</th>
<th>PTO speed</th>
<th>Application rate (gallons/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>1800</td>
<td>540</td>
<td>14,000</td>
</tr>
<tr>
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</tr>
<tr>
<td>L3</td>
<td>1800</td>
<td>540</td>
<td>9,700</td>
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<td>540</td>
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</tr>
<tr>
<td>H3</td>
<td>1800</td>
<td>540</td>
<td>5,800</td>
</tr>
</tbody>
</table>

**Example:**

Your waste application method is a tractor-drawn tanker (honeywagon) with a 2,500-gallon capacity. You apply a load to a field and measure the application area as 22 feet wide by 480 feet long. What is the application rate in gallons per acre?
First, figure the coverage area:

\[
\text{Coverage area (acres)} = \frac{480 \text{ ft} \times 22 \text{ ft}}{43,560 \text{ ft}^2/\text{acre}} = 0.24 \text{ acre}
\]

Then figure the application rate:

\[
\text{Application rate for spreader (gal/acre)} = \frac{2,500 \text{ gal}}{0.24 \text{ acres}} = 10,416.7 \text{ gal/acre}
\]

Calibration for hose drag systems is similar, but as opposed to using a volume from a tank, you measure volume pumped with a flowmeter attached to the system piping, and you apply that volume over the area (length times width) covered in the field.

Manure spreaders and hose-drag systems have an advantage over irrigation systems in that all areas in a field that meet setback restrictions can have uniform waste coverage. Manure spreaders can also be used to apply waste to portions of a sprayfield (as specified in the waste management plan) not reached by irrigation wastewater. **Changing waste application systems requires a modification to the waste management plan.**
Review Questions

1. What setbacks and buffers must be observed during waste application?

2. A proper pumping schedule seeks to balance what three things?

3. What are the four questions you should ask yourself before deciding to irrigate wastewater?

4. Describe how to determine the application rate from a stationary sprinkler irrigation system.

5. Explain how you can measure or calibrate your actual waste application (in inches) from an irrigation system.

6. Describe some advantages and disadvantages of irrigation systems and manure spreaders for waste application.
Chapter 7: Record Keeping—Type A

Records Management

Growers who use waste materials as fertilizer or a source of lime must maintain records of the analytical results, application rates, and soil tests for each application site. This section will address the importance of Records Management as a vital part of an animal waste management system.

Record keeping is required to keep up with the management of the waste application system. The forms included here are the current state-approved forms for recording information at a permittee’s animal operation. Maintaining these forms is required by state law and helps provide evidence that you are managing your waste management system properly.

Keeping accurate records, along with the implementation of proper BMPs on your farm, is the primary way you prove to DWR, DSWC (in pilot counties), and to the general public that your animal waste management system is not causing an environmental impact. Assistance with record keeping can be obtained from a Certified Technical Specialist or the NC Cooperative Extension, the Natural Resources Conservation Service, the local Soil and Water Conservation District, or the Agronomic Division of NCDA&CS.

In order to satisfy DWR’s and DSWC’s farm inspection procedures, the following items need to be available at the individual farm:

1. Waste application records
2. Map of farm fields including waste application fields and acreage
3. Certified Animal Waste Management Plan
4. Waste sample analysis (within 60 days of application)
5. Soil analysis at least once every three (3) years for each field receiving waste applications
6. Rain gauge readings and lagoon level readings
7. Past inspection reports and operational reviews
8. Animal stocking records
9. Records of additional nutrient sources applied (i.e; commercial fertilizer, sludge, lime)
10. Waste application equipment testing and calibration
11. Removal of waste to off-site locations
12. Results of sludge surveys
13. Crop yields
14. Annual certification form for NPDES permitted facilities

Describe the importance of record maintenance.

Describe what records need to be maintained to show compliance with environmental regulations.
These records must be maintained in chronological and legible form for a period specified by the permit at the individual farm. Farms with State Nondischarge Permits are required to keep records for three years. Farms with NPDES Permits are required to keep records for five years.

Forms typically require the signature of the Operator in Charge (OIC) for the facility. This is the individual who has been named by the farm manager or owner as the one person in charge of the waste application system.

On the forms that track nutrient loading to each field (IRR-2, SLUR-2, SLD-2), all nutrients that are applied to the field must be recorded. This includes any commercial fertilizer that may be added as a starter or supplemental nutrient source.

It may also be beneficial for you to maintain the additional following records for verification of conditions on your farm (you should review your permit to see if there are any of these or other items which may be required to be maintained to be compliant with DWR guidelines):

1. Plant analysis
2. Surface water and groundwater quality records

Forms included here are:

1. **IRR-1**: Lagoon Liquid Irrigation Field Record is to be used to record each irrigation event and to record the minimum 2-hour inspection of application of waste.
2. **IRR-2**: Cumulative Lagoon Liquid Irrigation Field Record is to record the total annual waste and nutrient application to one field per crop cycle. It provides for calculating the total nitrogen application to the field and comparing it to the recommended nitrogen loading rate.
3. **IRR-1/IRR-2**: Combination of Lagoon Liquid Irrigation Field Record and Cumulative Lagoon Liquid Irrigation Field Record.
4. **SLUR-1**: Liquid Manure Slurry Field Record is to be used to record each waste application event if the producer is using a slurry or pump and haul system.
5. **SLUR-2**: Cumulative Liquid Manure Slurry Field Record is to record the total annual waste and nutrient application to one field per crop cycle with a slurry or pump and haul system. It provides for calculating the total nitrogen application to the field and comparing it to the recommended nitrogen loading rate.
6. **SOLID-1**: Solid or Semisolid (dry stack) Field Record is to be used to record each waste application event if the producer is using a manure spreader or box spreader.
7. **SOLID-2**: Cumulative Solid Field Record is to record the total annual waste and nutrient application to one field per crop cycle. It provides for calculating the total nitrogen application to the field and comparing it to the recommended nitrogen loading rate.
8. **FRBD-1**: This form is used to record daily precipitation events and weekly waste structure freeboard levels.
9. **STOCK-1**: This form is used to track number of animals maintained on the farm. The average number of animals maintained may not exceed the permitted capacity specified in the facilities permit and waste management plan.

10. **CROP-1**: This form is used to track crop yields on fields that are used for waste application.

11. **TRAN-1**: This form is used to record the transfer of any waste between waste structures on the farm.

12. **DRAG-1**: This form is used to record hose-drag application records.

13. **ANNUAL CERTIFICATION FORM**: This form is used for NPDES permit holders to submit to the state each year.

14. **DEVICES TO AUTOMATICALLY STOP IRRIGATION EVENTS**: This form is used for NPDES permit holders to declare whether or not they wish to install automatic cutoff switches for rainfall on their irrigation equipment.

Records may be collected and maintained on a computer, PDA, or other electronic device; however, DWR does require that paper printouts of these records be kept on file.

The record forms IRR-2, SLUR-2, and SOLID-2 require the operator to make calculations to determine the amount of N that has been applied to a given crop. The necessary formulas to complete the forms are provided in the first row of the form.

> Note: For recording purposes, field size is that portion of the field that receives waste applications (often referred to as the “wetted acres” when using irrigation). Wetted acres are equal to or less than field size due to irrigation system layout and use of required buffers, or due to accessibility with spreader equipment.

Appendix F contains the following forms:

- **Change of Ownership**: Required when farm changes ownership
- **Change of Integrator**: Required when contractor changes integrator or companies
- **Inspection Form**: Used by DWR and DSWC staff when performing site inspections

> Note that alternative forms than those found in this manual may be used if: 1) They contain at a minimum all the information supplied by these forms in a logical, concise format, and 2) They are approved by DWR.

### Review Questions

1. Explain what waste management records must be maintained at an animal operation.

2. Describe what is to be done with waste application records.

3. Describe the difference between the field records (example IRR-1) and the cumulative total records (example IRR-2).
**Lagoon Liquid Irrigation Fields Record**  
For Recording Irrigation Events on Different Fields

<table>
<thead>
<tr>
<th>Tract &amp; Field #</th>
<th>Date (mm/dd/yr)</th>
<th>Crop Type</th>
<th>Field Size (acres)</th>
<th>Irrigation Time Start Time</th>
<th>End Time</th>
<th>Total Minutes</th>
<th># Sprinklers</th>
<th>Operator Initials</th>
<th>*Weather Code</th>
<th>**Inspections (initials)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Weather Codes: C-Clear, PC-Partly Cloudy, CI-Cloudy, R-Rain, S-Snow/Sleet, W-Windy

** Persons completing the irrigation inspections must initial to signify that inspections were completed at least every 120 minutes.

Note: If conditions beyond the permittee’s control have caused noncompliance with the CAWMP or permit, explain on reverse.

**IRR-1 Form 8/3/2012**
# Lagoon Liquid Irrigation Fields Record

**One Form for Each Field per Crop Cycle**

<table>
<thead>
<tr>
<th>Hydrant #</th>
<th>Field #</th>
<th>Facility Number</th>
</tr>
</thead>
</table>

| Field Size (wetted acres) = (A) |

<table>
<thead>
<tr>
<th>Farm Owner</th>
<th>Owner’s Address</th>
<th>Owner’s Phone #</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Crop Type</th>
</tr>
</thead>
</table>

### From Waste Utilization Plan

| Recommended PAN Loading (lb/acre) = (B) |

| Irrigation Volume PAN Applied Nitrogen Date Start End Total # of Flow Total Volume per Acre Waste Analysis PAN\* PAN Applied Nitrogen Balance** Source (lb/1000 gal) (lb/acre) (lb/1000 gal) (lb/acre) (lb/acre) (lb/acre) |
|-------------------------------|-------------------|-----------------|----------------------|------------------|-----------------|------------------|-----------------|------------------|
| ***Nutrient Source** (mm/dd/yr) | Start Time | End Time | Total Minutes (3) - (2) | # of Sprinklers Operating | Flow Rate (gal/min) | Total Volume (galons) | (6) x (5) x (4) | Waste Analysis PAN\* (8) x (9) | PAN Applied (lb/acre) (8) x (9) | Nitrogen Balance** (lb/acre) (B) - (10) |
|--------------------------------|------------|----------|------------------------|--------------------------|------------------|---------------------|------------------|-----------------------------|------------------|-----------------------------|---------------------------|
|                                |            |          |                        |                          |                  |                     |                  |                             |                  |                             |                           |
|                                |            |          |                        |                          |                  |                     |                  |                             |                  |                             |                           |
|                                |            |          |                        |                          |                  |                     |                  |                             |                  |                             |                           |
|                                |            |          |                        |                          |                  |                     |                  |                             |                  |                             |                           |
|                                |            |          |                        |                          |                  |                     |                  |                             |                  |                             |                           |
|                                |            |          |                        |                          |                  |                     |                  |                             |                  |                             |                           |
|                                |            |          |                        |                          |                  |                     |                  |                             |                  |                             |                           |

| Crop Cycle Totals |

<table>
<thead>
<tr>
<th>Owner’s Signature</th>
<th>Operator’s Signature</th>
<th>Certified Operator (Print)</th>
<th>Operator’s Certification No.</th>
</tr>
</thead>
</table>

* NCDA Waste Analysis or Equivalent. At a minimum, waste analysis is required within 60 days of land application events.

** Enter the value received by subtracting column (10) from (B). Continue subtracting column (10) from column (11) following each irrigation event.

*** Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)
### Lagoon Liquid Irrigation Fields Record

**One Form for Each Field per Crop Cycle**

<table>
<thead>
<tr>
<th>Zone #</th>
<th>Facility Number</th>
<th>Irrigation Operator</th>
<th>Irrigation Operator's Address</th>
<th>Operator's Phone #</th>
</tr>
</thead>
</table>

#### From Waste Utilization Plan

- **Crop Type**
- **Recommended PAN**
- **Loading (lb/acre)**

<table>
<thead>
<tr>
<th>(1)</th>
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<th>(7)</th>
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<th>(9)</th>
<th>(10)</th>
<th>(11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lagoon ID</td>
<td>Date Start</td>
<td>Irrigation Volume</td>
<td>PAN Applied</td>
<td>Waste Analysis</td>
<td>Nitrogen Balance</td>
<td>Weather Code</td>
<td>Inspections</td>
<td></td>
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</tr>
</tbody>
</table>

- **Total Volume (gal/acre)**: \((\text{Total Flow Rate} \times \text{Flow Rate}) / \text{Field Size} \) (wetted acres)
- **Waste Analysis Pan** = \((\text{PAN} \times 1000) / 1000\)
- **Nitrogen Balance** = \((\text{PAN} \times 1000) / 1000\)

**Crop Cycle Totals =**

---

* NCDA Waste Analysis or Equivalent. At a minimum, waste analysis is required within 60 days of land application events.

** Enter the value received by subtracting column (10) from (B). Continue subtracting column (10) from column (11) following each irrigation event.

*** Enter nutrient source (ie. Lagoon/Storage Pond ID, commercial fertilizer, dry litter, etc.)

---

Certified Operator (Print) ___________________________ Operator’s Certification No. ___________________________

Owner’s Signature ___________________________ Operator’s Signature ___________________________

Combined IRR1/2 Form - 8/3/2012
### Form SLUR-1

**Slurry and Sludge Application Field Record**

For recording slurry application events on different fields.

<table>
<thead>
<tr>
<th>Tract &amp; Field #</th>
<th>Date (mm/dd/yr)</th>
<th>Field Size (acres)</th>
<th>Crop Type</th>
<th>Application Method*</th>
<th>Number of Loads per Field</th>
<th>Volume of each Load** (gallons)</th>
<th>Weather Code</th>
<th>Weather Codes: C-Clear, PC-Partly Cloudy, Cl-Cloudy, R-Rain, S-Snow/Sleet, W-Windy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>SI = soil incorporated (disked); BR = broadcast (surface applied).</td>
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<td>Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.</td>
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</tbody>
</table>

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* SI = soil incorporated (disked); BR = broadcast (surface applied).
** Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.
### Form SLUR-2

**Slurry and Sludge Application Field Records**

**One Form for Each Field per Crop Cycle**

<table>
<thead>
<tr>
<th>Tract #</th>
<th>Field #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Facility Number</td>
</tr>
</tbody>
</table>

**From Animal Waste Management Plan**

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Recommended PAN Loading (lb/acre) = (B)</th>
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</thead>
<tbody>
<tr>
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</table>

<table>
<thead>
<tr>
<th>***Nutrient Source</th>
<th>Date (mm/dd/yr)</th>
<th>Number of Loads per Field</th>
<th>Volume of each Load* (gallons)</th>
<th>Total Volume (gallons)</th>
<th>Volume per Acre (gallons/acre)</th>
<th>Waste Analysis PAN** (lb/1000 gill)</th>
<th>PAN Applied (lb/acre)</th>
<th>Nitrogen Balance*** (lb/acre)</th>
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</table>

**Crop Cycle Totals:**

<table>
<thead>
<tr>
<th>Owners Signature</th>
<th>Spreader Operator’s Signature</th>
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</table>

Certified Operator (print) __________________________ Operator Certification No. __________________________

* Can be found in operator’s manual for the spreader. Contact a local dealer if you do not have your owner’s manual.

** See your waste management plan for sampling frequency. At a minimum, waste analysis is required within 60 days of land application events.

***Enter the value received by subtracting column (7) from (B). Continue subtracting column (7) from column (8) following each application event.

***Enter nutrient source (ie. Lagoon/Storage Pond ID, commercial fertilizer, dry litter, etc.)

12/20/06
### Form SOLD-1

**Manure Solids Application Field Record**

For Recording Manure Solids Application Events on Different Fields

<table>
<thead>
<tr>
<th>Tract &amp; Field #</th>
<th>Date (mm/dd/yr)</th>
<th>***Weather Code</th>
<th>Crop Type</th>
<th>Field Size (acres)</th>
<th>Application Method*</th>
<th>Number of Loads per Field</th>
<th>Volume of each Load** (tons)</th>
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</table>

* SI = soil incorporated (disked); BR = broadcast (surface applied).

** Can be found in operator's manual for the spreader. Contact a local dealer if you do not have your owner's manual.

*** Weather Codes: C-Clear, PC-Partly Cloudy, CI-Cloudy, R-Rain, S-Snow/Sleet, W-Windy

3/14/03
### Form SLD-2

**Manure Solids Application Field Records**

**One Form for Each Field per Crop Cycle**

<table>
<thead>
<tr>
<th>Field #</th>
<th>Facility Number</th>
<th>Facility Name</th>
<th>Facility Address</th>
<th>Spreader Operator</th>
<th>Spreader and Address</th>
<th>Owner's Phone #</th>
<th>Facility Number</th>
<th>Facility Name</th>
<th>Facility Address</th>
<th>Spreader Operator</th>
<th>Spreader and Address</th>
<th>Owner's Phone #</th>
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</thead>
<tbody>
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</tbody>
</table>

**From Animal Waste Management Plan**

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Recommended PAN Loading (lb/acre) = (B)</th>
<th>Loading (lb/acre) = (B)</th>
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</table>

**Crop Cycle Totals:**

<table>
<thead>
<tr>
<th><strong>Crop Cycle Totals:</strong></th>
<th><strong>Crop Cycle Totals:</strong></th>
</tr>
</thead>
</table>

**Owners Signature** ____________________________  **Spreader Operator’s Signature** ____________________________

**Certified Operator (print):** ____________________________  **Operator Certification No.:** ____________________________

*Can be found in operator’s manual for the spreader. Contact a local dealer if you do not have your owner’s manual.*  

**See your waste management plan for sampling frequency. At a minimum, waste analysis is required within 60 days of land application events.*

***Enter the value received by subtracting column (7) from (B). Continue subtracting column (7) from column (8) following each application event.***

***Enter nutrient source (ie. Lagoon/Storage Pond ID, commercial fertilizer, dry litter, etc.)***

12/20/06
Form FRBD 1

**Waste Structure Freeboard and Daily Precipitation Record**

<table>
<thead>
<tr>
<th>Day</th>
<th>Waste Structure Freeboard (inches)</th>
<th>Precipitation (inches)</th>
<th>Initials</th>
<th>Comments</th>
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</table>

1. Lagoon freeboard is the difference between the lowest point of a lagoon embankment and the level of liquid. For lagoons with spillways, the difference between the level of liquid and the bottom of the spillway should be recorded.
2. Freeboard levels must be recorded at least weekly.
3. Rainfall must be recorded for every rain event.
Average Stocking and Mortality Record

<table>
<thead>
<tr>
<th>*Date (mm/dd/yyyy)</th>
<th>Previous Stocked</th>
<th>Placement Stocked</th>
<th>Stock Shipped</th>
<th>Mortality</th>
<th>**Total Stock</th>
<th>***Average Stock</th>
<th>****Average Mortality</th>
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* At a minimum, records must be kept monthly.

** Total Stocked (5): equals (1) + (2) - (3) - (4)

*** Average Stocked (6): Add previous 12 months of Total Stocked (5) and divide by # of entries.

**** Average Mortality (7): Add previous 12 months Mortality (4) and divide by # of entries.

3/14/03
### CROP YIELD RECORD

<table>
<thead>
<tr>
<th>Date (mm/dd/yyyy)</th>
<th>Field/Pull ID</th>
<th>Crop</th>
<th>(1) Yield (Bales or Bushels)</th>
<th>Bale Size (if applicable)</th>
<th>(2) Field/Pull Size (wetted acres)</th>
<th>(3) Yield per Acre (Bale or Bushel/Ac)</th>
</tr>
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</tbody>
</table>

* (3) Yield/Acre = (1) Yield divided by (2) Field/Pull Size. (3)=(1)/(2) 3/14/03
# Form TRAN-1

Record Each Transfer of Waste Between Lagoons or Third Party

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Nutrient Analysis</th>
<th>Transfer From (Lagoon ID or third party)</th>
<th>*Volume Transferred</th>
<th>Permit #</th>
<th>Phone #</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

*Volume Transferred must be recorded in gallons, tons, or cubic yards.

**Third Party Information

Waste Transfers over 4 cubic yards must be accepted by a permitted facility or a field in the permittee's WUP.

FORM TRAN-1
## Lagoon Liquid Hose Drag Application Fields Record

For Recording Hose Drag Application Events on Different Fields

### Form DRAG-1

<table>
<thead>
<tr>
<th>Tract &amp; Field #</th>
<th>Date (mm/dd/yr)</th>
<th>Crop Type</th>
<th>Field Size (acres)</th>
<th>Hose Drag Application Time</th>
<th>Flow Rate (gal/min)</th>
<th>Hydrant #'s Or Zones</th>
<th>Total Volume (gallons)</th>
<th>Volume per Acre (gal/acre)</th>
<th>Operator Initials</th>
<th>&quot;Weather Code&quot;</th>
</tr>
</thead>
<tbody>
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</tr>
</tbody>
</table>

* Weather Codes: C-Clear, PC-Partly Cloudy, CI-Cloudy, R-Rain, S-Snow/Sleet, W-Windy

** Persons completing the irrigation inspections must initial to signify that inspections were completed at least every 120 minutes.

Note: If conditions beyond the permittee's control have caused noncompliance with the CAWMP or permit, explain on reverse.

3/14/06
Annual Certification Form

ANIMAL FACILITY ANNUAL CERTIFICATION FORM

Certificate of Coverage or Permit Number ______________________ County ________________ Year 200__

Facility Name (as shown on Certificate of Coverage or Permit) ______________________________

Operator in Charge for this Facility ______________________________ Certification #________________

Land application of animal waste as allowed by the above permit occurred during the past calendar year
_____ YES _____ NO. If NO, skip Part I and Part II and proceed to the certification. Also, if animal waste
was generated but not land applied, please attach an explanation on how the animal waste was handled.

Part I: Facility Information:

1. Total number of application Fields ☐ or Pulls ☐ (please check the appropriate box) in the Certified Animal
   Waste Management Plan (CAWMP): _______________ Total Useable Acres approved in the CAWMP
   __________________

2. Total number of Fields ☐ or Pulls ☐ (please check the appropriate box) on which land application
   occurred during the year: _______________ Total Acres on which waste was applied _______________

3. Total pounds of Plant Available Nitrogen (PAN) applied during the year for all application sites:
   __________________________________

4. Total pounds of Plant Available Nitrogen (PAN) allowed to be land applied annually by the CAWMP and
   the permit: __________________________

5. Estimated amount of total manure, litter and process wastewater sold or given to other persons and taken
   off site during the year ________________ tons ☐ or gallons ☐ (please check the appropriate box)

6. Annual average number of animals by type at this facility during the previous year:
   _______________________________________________________________________________________

7. Largest and smallest number of animals by type at this facility at any one time during the previous year:
   Largest __________________________________________________________________________________
   Smallest _________________________________________________________________________________

   (These numbers are for informational purposes only since the only permit limit on the number of animals
   at the facility is the annual average numbers)

8. Facility’s Integrator if applicable: __________________________________________________________

Part II: Facility Status:

IF THE ANSWER TO ANY STATEMENT BELOW IS “NO”, PLEASE PROVIDE A WRITTEN
DESCRIPTION AS TO WHY THE FACILITY WAS NOT COMPLIANT, THE DATES OF ANY NON
COMPLIANCE, AND EXPLAIN CORRECTIVE ACTION TAKEN OR PROPOSED TO BE TAKEN TO
BRING THIS FACILITY BACK INTO COMPLIANCE.

1. Only animal waste generated at this facility was applied to the permitted sites during
   the past calendar year. ☐ Yes ☐ No

2. The facility was operated in such a way that there was no direct runoff of waste from
   ☐ Yes ☐ No

AFACF 3-14-03
the facility (including the houses, lagoons/storage ponds and the application sites) during the past calendar year.

3. There was no discharge of waste to surface water from this facility during the past calendar year. ☐ Yes ☐ No

4. There was no freeboard violation in any lagoons or storage ponds at this facility during the past calendar year. ☐ Yes ☐ No

5. There was no PAN application to any fields or crops at this facility greater than the levels specified in this facility’s CAWMP during the past calendar year. ☐ Yes ☐ No

6. All land application equipment was calibrated at least once during the past calendar year. ☐ Yes ☐ No

7. Sludge accumulation in all lagoons did not exceed the volume for which the lagoon was designed or reduce the lagoon’s minimum treatment volume to less than the volume for which the lagoon was designed. ☐ Yes ☐ No

8. A copy of the Annual Sludge Survey Form for this facility is attached to this Certification. ☐ Yes ☐ No

9. Annual soils analysis were performed on each field receiving animal waste during the past calendar year. ☐ Yes ☐ No

10. Soil pH was maintained as specified in the permit during the past calendar year? ☐ Yes ☐ No

11. All required monitoring and reporting was performed in accordance with the facility’s permit during the past calendar year. ☐ Yes ☐ No

12. All operations and maintenance requirements in the permit were complied with during the past calendar year or, in the case of a deviation, prior authorization was received from the Division of Water Quality. ☐ Yes ☐ No

13. Crops as specified in the CAWMP were maintained during the past calendar year on all sites receiving animal waste and the crops grown were removed in accordance with the facility’s permit. ☐ Yes ☐ No

14. All buffer requirements as specified on the permit and the CAWMP for this facility were maintained during each application of animal waste during the past calendar year. ☐ Yes ☐ No

“I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.”

Permittee Name and Title (type or print)

____________________________________________________________________

Signature of Permittee    Date

____________________________________________________________________

Signature of Operator in Charge (if different from Permittee)    Date

AFACF 3-14-03
Devices to Automatically Stop Irrigation Events Form

DEVICES TO AUTOMATICALLY STOP IRRIGATION EVENTS

The State of North Carolina has issued NPDES General Permits for animal facilities to operate in North Carolina. These Permits meet both State and EPA requirements and provide coverage for the following types of facilities.

NCA200000 (Swine Facilities)
NCA300000 (Cattle Facilities)
NCA400000 (Poultry Facilities with a wet waste management system)

You have recently been issued a Certificate of Coverage (COC) to operate your animal facility under one of these General Permits.

Condition II. 16. of each of these Permits reads as follows:

Within one hundred and twenty (120) days of the effective date of a COC issued under this permit, the permittee shall install, operate and maintain devices on all irrigation pumps/equipment designed to automatically stop irrigation activities during precipitation. This condition does not apply to manure spreaders or other equipment pulled by manned vehicles.

The permittee will not be required to install, operate and maintain the devices if the permittee commits to provide for the presence of the OIC or the designated backup OIC at all times during the land application of waste. This commitment must be submitted in writing to the Division prior to the 120th day following the effective date of the COC on a form supplied by, or approved by, the Division.

Please check the box below that indicates your commitment to do one of the following.

☐ Within one hundred and twenty (120) days of the effective date of a COC issued under this permit, I shall install, operate and maintain devices on all irrigation pumps/equipment designed to automatically stop irrigation activities during precipitation. This condition does not apply to manure spreaders or other equipment pulled by manned vehicles.

☐ I will commit to provide for the presence of the Operator in Charge (OIC) or the designated backup OIC at all times during the land application of waste.

“I certify under penalty of law that this document was prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.”

Facility Name________________________________________    Facility Number ________ - _______
Permit Number____________________________________________
_____________________________________________________________________

Permittee Name and Title (type or print)

__________________________    __________________________
Signature of Permittee    Date

__________________________    __________________________
Signature of Operator in Charge    Date
(if different from Permittee)

DTASIE 3-14-03
Example: Irrigation Records

Use Forms IRR-I and IRR-2:

Joe Pigford maintains a 2,600 head weanling-to-feeder operation. His estimated volume of lagoon liquid generated annually is approximately 496,600 gallons. He conducted a waste analysis on March 10th and June 22nd. The March 10th analysis showed the waste contained 1.2 pounds of plant-available nitrogen (PAN) per 1,000 gallons, and the June 22nd analysis showed the waste contained 1.7 pounds of PAN per 1,000 gallons. He irrigates two crops with wastewater using a traveling gun that applies 100 gallons per minute (GPM).

- Traveling gun pulls are considered Fields A and B, 1.41 acres each, and are established in bermuda hay.
- Traveling gun pulls are considered Fields C and D, 2.62 acres each, and are planted in corn.

His waste utilization plan shows that his anticipated yield for corn is 100 bushels per acre and he should apply 1.25 pounds of PAN per bushel yield. His yield of bermudagrass is estimated at 6 tons per acre and he should apply 50 pounds of PAN per ton of yield.

Fields A and B: PAN needed for bermuda hay:

\[
\frac{6 \text{ tons hay}}{\text{acre}} \times \frac{50 \text{ lb PAN}}{\text{ton}} = 300 \text{ lb PAN/acre}
\]

Fields C and D: PAN needed for corn:

\[
\frac{100 \text{ bu corn}}{\text{acre}} \times \frac{1.25 \text{ lb PAN}}{\text{bushel}} = 125 \text{ lb PAN/acre}
\]

Joe’s Lagoon Liquid Irrigation Field Record (Form IRR-I) follows. Transfer the information for Fields B and C each on a separate Form IRR-2 and complete the calculations to determine whether Joe has met his nitrogen requirement for his corn and bermuda crops. Round off to two decimal points on the PAN applied, shown in Column 10 on Form IRR-2.
<table>
<thead>
<tr>
<th>Tract &amp; Field #</th>
<th>Date (mm/dd/yr)</th>
<th>Crop Type</th>
<th>Field Size (acres)</th>
<th>Irrigation Time</th>
<th># Sprinklers</th>
<th>Operator</th>
<th>*Weather</th>
<th>**Inspections</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3/21</td>
<td>Bermuda</td>
<td>1.41</td>
<td>08:00 AM - 12:00 PM</td>
<td>1</td>
<td>JP</td>
<td>C</td>
<td>JP, SJ, VW, JP</td>
</tr>
<tr>
<td>B</td>
<td>3/21</td>
<td>Bermuda</td>
<td>1.41</td>
<td>03:00 PM - 07:00 PM</td>
<td>1</td>
<td>JP</td>
<td>C</td>
<td>JP, SJ, JP</td>
</tr>
<tr>
<td>C</td>
<td>3/22</td>
<td>Com</td>
<td>2.62</td>
<td>08:00 AM - 02:30 PM</td>
<td>1</td>
<td>JP</td>
<td>PC</td>
<td>JP, SJ, JP</td>
</tr>
<tr>
<td>D</td>
<td>3/23</td>
<td>Com</td>
<td>2.62</td>
<td>08:00 AM - 02:30 PM</td>
<td>1</td>
<td>JP</td>
<td>Cl</td>
<td>JP, SJ, CW, JP</td>
</tr>
<tr>
<td>C</td>
<td>3/28</td>
<td>Com</td>
<td>2.62</td>
<td>08:00 AM - 04:00 PM</td>
<td>1</td>
<td>JP</td>
<td>C</td>
<td>JP, VW, CW, SJ, JP</td>
</tr>
<tr>
<td>B</td>
<td>3/28</td>
<td>Bermuda</td>
<td>1.41</td>
<td>05:00 PM - 07:20 PM</td>
<td>1</td>
<td>JP</td>
<td>C</td>
<td>JP, JP</td>
</tr>
<tr>
<td>A</td>
<td>5/10</td>
<td>Bermuda</td>
<td>1.41</td>
<td>08:30 AM - 12:45 PM</td>
<td>1</td>
<td>JP</td>
<td>PC</td>
<td>JP, SJ, JP</td>
</tr>
<tr>
<td>B</td>
<td>5/11</td>
<td>Bermuda</td>
<td>1.41</td>
<td>08:30 AM - 12:30 PM</td>
<td>1</td>
<td>JP</td>
<td>Cl</td>
<td>JP, CW, SJ, JP</td>
</tr>
<tr>
<td>C</td>
<td>5/12</td>
<td>Com</td>
<td>2.62</td>
<td>08:30 AM - 03:00 PM</td>
<td>1</td>
<td>JP</td>
<td>C</td>
<td>JP, SJ, VW, JP</td>
</tr>
<tr>
<td>D</td>
<td>5/13</td>
<td>Com</td>
<td>2.62</td>
<td>08:30 AM - 04:00 PM</td>
<td>1</td>
<td>JP</td>
<td>PC</td>
<td>JP, CW, SJ, VW, JP</td>
</tr>
<tr>
<td>C</td>
<td>5/16</td>
<td>Com</td>
<td>2.62</td>
<td>07:00 AM - 01:40 PM</td>
<td>1</td>
<td>JP</td>
<td>Cl</td>
<td>JP, SJ, CW, JP</td>
</tr>
<tr>
<td>B</td>
<td>5/17</td>
<td>Bermuda</td>
<td>1.41</td>
<td>03:00 PM - 07:20 PM</td>
<td>1</td>
<td>JP</td>
<td>C</td>
<td>JP, SJ, JP</td>
</tr>
<tr>
<td>C</td>
<td>6/1</td>
<td>Com</td>
<td>2.62</td>
<td>08:00 AM - 04:00 PM</td>
<td>1</td>
<td>JP</td>
<td>PC</td>
<td>JP, CW, SJ, VW, JP</td>
</tr>
<tr>
<td>B</td>
<td>6/2</td>
<td>Bermuda</td>
<td>1.41</td>
<td>03:00 PM - 07:20 PM</td>
<td>1</td>
<td>JP</td>
<td>Cl</td>
<td>JP, SJ, JP</td>
</tr>
<tr>
<td>D</td>
<td>7/20</td>
<td>Com</td>
<td>2.62</td>
<td>10:00 AM - 03:30 PM</td>
<td>1</td>
<td>JP</td>
<td>C</td>
<td>JP, CW, SP</td>
</tr>
<tr>
<td>B</td>
<td>7/21</td>
<td>Bermuda</td>
<td>1.41</td>
<td>04:00 PM - 08:20 PM</td>
<td>1</td>
<td>JP</td>
<td>PC</td>
<td>JP, SJ, JP</td>
</tr>
</tbody>
</table>

* Weather Codes: C-Clear, PC-Partly Cloudy, Cl-Cloudy, R-Rain, S-Snow/Sleet, W-Windy

** Persons completing the irrigation inspections must initial to signify that inspections were completed at least every 120 minutes.

Note: If conditions beyond the permittee's control have caused noncompliance with the CAWMP or permit, explain on reverse.
**Chapter 7: Record Keeping—Type A**

**Lagoon Liquid Irrigation Fields Record**
One Form for Each Field per Crop Cycle

<table>
<thead>
<tr>
<th>Hydrant #</th>
<th>A</th>
<th>Field #</th>
<th>A</th>
<th>Facility Number</th>
<th>99 - 999</th>
</tr>
</thead>
</table>

Field Size (wetted acres) = **A**

1.41

**Farm Owner**
Joe Pigford

**Owner’s Address**
123 Any Street
Anytown, NC

**Irrigation Operator**
Joe Pigford

**Irrigation Operator’s Address**
123 Street
Anytown, NC

**Operator’s Phone #**

**Crop Type**
Bermuda

**Recommended PAN**
Loading (lb/acre) = **B**

300

**From Waste Utilization Plan**

<table>
<thead>
<tr>
<th><strong>Nutrient Source</strong></th>
<th><strong>Date (mm/dd/yr)</strong></th>
<th><strong>Start Time</strong></th>
<th><strong>End Time</strong></th>
<th><strong>Total Minutes (3) - (2)</strong></th>
<th><strong># of Sprinklers Operating</strong></th>
<th><strong>Flow Rate (gal/min)</strong></th>
<th><strong>Total Volume (gallons) (8) x (5) x (4)</strong></th>
<th><strong>Volume per Acre (gal/acre) (7) / (A)</strong></th>
<th><em><em>Waste Analysis PAN</em> (lb/1000 gal)</em>*</th>
<th><strong>PAN Applied (lb/acre) (B) x (9) / 1000</strong></th>
<th><strong>Nitrogen Balance</strong> (lb/acre) (B) - (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lagoon 1</td>
<td>3/21</td>
<td>08:00</td>
<td>12:00</td>
<td>240</td>
<td>1</td>
<td>100</td>
<td>24000</td>
<td>17021.28</td>
<td>1.2</td>
<td>20.43</td>
<td>279.57</td>
</tr>
<tr>
<td>Lagoon 1</td>
<td>5/10</td>
<td>08:30</td>
<td>12:45</td>
<td>255</td>
<td>1</td>
<td>100</td>
<td>25500</td>
<td>18085.11</td>
<td>1.7</td>
<td>30.74</td>
<td>248.83</td>
</tr>
</tbody>
</table>

| **Crop Cycle Totals** | 49500 | 51.17 |

**Owner’s Signature**
Joe Pigford

**Operator’s Signature**
Joe Pigford

**Certified Operator (Print)**
Joe Pigford

**Operator’s Certification No.**
99999

---

* NCDA Waste Analysis or Equivalent. At a minimum, waste analysis is required within 60 days of land application events.
** Enter the value received by subtracting column (10) from (B). Continue subtracting column (10) from column (11) following each irrigation event.
*** Enter nutrient source (ie. Lagoon/Storage Pond ID, commercial fertilizer, dry litter, etc.)
**FORM IRR-2**

Lagoon Liquid Irrigation Fields Record  
One Form for Each Field per Crop Cycle

<table>
<thead>
<tr>
<th>Hydrant #</th>
<th>B</th>
<th>Field #</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Field Size (wetted acres) = (A)

<table>
<thead>
<tr>
<th>Facility Number</th>
<th>99 - 999</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Farm Owner

<table>
<thead>
<tr>
<th>Name</th>
<th>Joe Pigford</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner's Address</td>
<td>123 Any Street</td>
</tr>
<tr>
<td>Anytown, NC</td>
<td></td>
</tr>
</tbody>
</table>

Irrigation Operator

<table>
<thead>
<tr>
<th>Name</th>
<th>Joe Pigford</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator's Address</td>
<td>123 Street</td>
</tr>
<tr>
<td>Anytown, NC</td>
<td></td>
</tr>
</tbody>
</table>

Crop Type

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Bermuda</th>
</tr>
</thead>
</table>

**From Waste Utilization Plan**

Recommended PAN Loading (lb/acre) = (B)

<table>
<thead>
<tr>
<th>Loading (lb/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>Date (mm/dd/yr)</th>
<th>Time Start</th>
<th>Time End</th>
<th>Total Minutes (3) - (2)</th>
<th># of Sprinklers Operating</th>
<th>Flow Rate (gal/min)</th>
<th>Total Volume (galions) (6) x (5) x (4)</th>
<th>Total Volume per Acre (gal/acre) (7) / (A)</th>
<th>Waste Analysis PAN* (lb/1000 gal)</th>
<th>PAN Applied (lb/acre) (B)</th>
<th>Nitrogen Balance** (lb/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lagoon 1</td>
<td>3/21</td>
<td>3:00 PM</td>
<td>7:00 PM</td>
<td>240</td>
<td>1</td>
<td>100</td>
<td>24000</td>
<td>17021.28</td>
<td>1.2</td>
<td>20.43</td>
<td>279.57</td>
</tr>
<tr>
<td>Lagoon 1</td>
<td>3/28</td>
<td>05:00 PM</td>
<td>07:00 PM</td>
<td>140</td>
<td>1</td>
<td>100</td>
<td>14000</td>
<td>9929.08</td>
<td>1.2</td>
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<td>267.66</td>
</tr>
<tr>
<td>Lagoon 1</td>
<td>5/11</td>
<td>08:30 AM</td>
<td>12:30 PM</td>
<td>240</td>
<td>1</td>
<td>100</td>
<td>24000</td>
<td>17021.28</td>
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<td>28.94</td>
<td>238.72</td>
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<tr>
<td>Lagoon 1</td>
<td>5/17</td>
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<td>07:20 PM</td>
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<td>1</td>
<td>100</td>
<td>26000</td>
<td>18439.72</td>
<td>1.7</td>
<td>31.35</td>
<td>207.38</td>
</tr>
<tr>
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<td>6/2</td>
<td>03:00 PM</td>
<td>07:20 PM</td>
<td>260</td>
<td>1</td>
<td>100</td>
<td>26000</td>
<td>18439.72</td>
<td>1.7</td>
<td>31.35</td>
<td>176.03</td>
</tr>
<tr>
<td>Lagoon 1</td>
<td>7/21</td>
<td>04:00 PM</td>
<td>08:20 PM</td>
<td>260</td>
<td>1</td>
<td>100</td>
<td>26000</td>
<td>18439.72</td>
<td>1.7</td>
<td>31.35</td>
<td>144.68</td>
</tr>
</tbody>
</table>

Crop Cycle Totals

<table>
<thead>
<tr>
<th>Total Volume</th>
<th>140000</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Total Nitrogen Balance</th>
<th>1553191489</th>
</tr>
</thead>
</table>

* NCDA Waste Analysis or Equivalent. At a minimum, waste analysis is required within 60 days of land application events.

** Enter the value received by subtracting column (10) from (B). Continue subtracting column (10) from column (11) following each irrigation event.

***Enter nutrient source (ie. Lagoon/Storage Pond ID, commercial fertilizer, dry litter, etc.)
**FORM IRR-2**

Lagoon Liquid Irrigation Fields Record
One Form for Each Field per Crop Cycle

<table>
<thead>
<tr>
<th>Hydrant #</th>
<th>C</th>
<th>Field #</th>
<th>C</th>
</tr>
</thead>
</table>

Field Size (wetted acres) = (A) 2.62

<table>
<thead>
<tr>
<th>Farm Owner</th>
<th>Joe Pigford</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner's Address</td>
<td>123 Any Street</td>
</tr>
<tr>
<td>Anytown, NC</td>
<td></td>
</tr>
<tr>
<td>Owner's Phone #</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Corn</th>
</tr>
</thead>
</table>

From Waste Utilization Plan

**Recommended PAN Loading (lb/acre) = (B)** 125

<table>
<thead>
<tr>
<th><strong>Nutrient Source</strong></th>
<th>Date</th>
<th>Start Time</th>
<th>End Time</th>
<th>Total Minutes (3) - (2)</th>
<th># of Sprinklers Operating</th>
<th>Flow Rate (gal/min)</th>
<th>Total Volume (gallons) (B) x (5) x (4)</th>
<th>Volume per Acre (gal/acre) (7) / (A)</th>
<th>Waste Analysis PAN* (lb/1000 gal)</th>
<th>PAN Applied (b/acre) (B) x (9)</th>
<th>Nitrogen Balance** (lb/acre) (B) - (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lagoon 1</td>
<td>3/22</td>
<td>8:00 AM</td>
<td>2:30 PM</td>
<td>390</td>
<td>1</td>
<td>100</td>
<td>39000</td>
<td>14885.50</td>
<td>1.2</td>
<td>17.86</td>
<td>107.14</td>
</tr>
<tr>
<td>Lagoon 1</td>
<td>3/28</td>
<td>08:00 AM</td>
<td>04:00 PM</td>
<td>480</td>
<td>1</td>
<td>100</td>
<td>48000</td>
<td>18320.61</td>
<td>1.2</td>
<td>21.98</td>
<td>85.15</td>
</tr>
<tr>
<td>Lagoon 1</td>
<td>5/12</td>
<td>08:30 AM</td>
<td>03:00 PM</td>
<td>390</td>
<td>1</td>
<td>100</td>
<td>39000</td>
<td>14885.50</td>
<td>1.7</td>
<td>25.31</td>
<td>59.85</td>
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<td>Lagoon 1</td>
<td>5/16</td>
<td>07:00 AM</td>
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<td>1</td>
<td>100</td>
<td>40000</td>
<td>15267.18</td>
<td>1.7</td>
<td>25.95</td>
<td>33.89</td>
</tr>
<tr>
<td>Lagoon 1</td>
<td>6/1</td>
<td>08:00 AM</td>
<td>04:00 PM</td>
<td>480</td>
<td>1</td>
<td>100</td>
<td>48000</td>
<td>18320.61</td>
<td>1.7</td>
<td>31.15</td>
<td>2.75</td>
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</table>

Crop Cycle Totals 214000 1222519084

Owner's Signature Joe Pigford
Certified Operator (Print) Joe Pigford
Operator's Signature Joe Pigford
Operator's Certification No. 99999

* NCDA Waste Analysis or Equivalent. At a minimum, waste analysis is required within 60 days of land application events.
** Enter the value received by subtracting column (10) from (B). Continue subtracting column (10) from column (11) following each irrigation event.
***Enter nutrient source (ie. Lagoon/Storage Pond ID, commercial fertilizer, dry litter, etc.)
**FORM IRR-2**

Lagoon Liquid Irrigation Fields Record  
One Form for Each Field per Crop Cycle

<table>
<thead>
<tr>
<th>Hydrant #</th>
<th>Field #</th>
<th>Hydrant #</th>
<th>Field #</th>
<th>Facility Number</th>
<th>Hydrant #</th>
<th>Field #</th>
<th>Hydrant #</th>
<th>Field #</th>
<th>Facility Number</th>
</tr>
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<tbody>
<tr>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>99</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>999</td>
</tr>
</tbody>
</table>

Field Size (wetted acres) = (A) 2.62

Farm Owner: Joe Pigford  
Owner's Address: 123 Any Street, Anytown, NC

Irrigation Operator: Joe Pigford  
Irrigation Operator's Address: 123 Street, Anytown, NC

Crop Type: Corn

| From Waste Utilization Plan | Recommended PAN Loading (lb/acre) = (B) 125
|----------------------------|----------------------------------|

<table>
<thead>
<tr>
<th>Irrigation</th>
<th>Date (mm/dd/yr)</th>
<th>Start Time</th>
<th>End Time</th>
<th>Total Minutes (3) - (2)</th>
<th># of Sprinklers Operating</th>
<th>Flow Rate (gall/min)</th>
<th>Total Volume (gallons)</th>
<th>Volume per Acre (gal/acre)</th>
<th>Waste Analysis PAN* (lb/1000 gal)</th>
<th>PAN Applied (lb/acre) (8) x (9)</th>
<th>Nitrogen Balance* (lb/acre) (5) - (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lagoon 1</td>
<td>3/23</td>
<td>8:00 AM</td>
<td>2:30 PM</td>
<td>390</td>
<td>1</td>
<td>100</td>
<td>39000</td>
<td>14885.50</td>
<td>1.2</td>
<td>17.86</td>
<td>107.14</td>
</tr>
<tr>
<td>Lagoon 1</td>
<td>5/13</td>
<td>08:30 AM</td>
<td>04:00 PM</td>
<td>450</td>
<td>1</td>
<td>100</td>
<td>45000</td>
<td>17175.57</td>
<td>1.7</td>
<td>29.20</td>
<td>77.94</td>
</tr>
<tr>
<td>Lagoon 1</td>
<td>7/20</td>
<td>10:00 AM</td>
<td>03:30 PM</td>
<td>330</td>
<td>1</td>
<td>100</td>
<td>33000</td>
<td>12595.42</td>
<td>1.7</td>
<td>21.41</td>
<td>56.53</td>
</tr>
</tbody>
</table>

**Crop Cycle Totals**: 117000  
**Nitrogen Balance**: 68.47

Owner's Signature: Joe Pigford  
Operator's Signature: Joe Pigford

Certified Operator (Print): John Pigford  
Operator's Certification No.: 99999

---

* NCDA Waste Analysis or Equivalent. At a minimum, waste analysis is required within 60 days of land application events.

** Enter the value received by subtracting column (10) from (B). Continue subtracting column (10) from column (11) following each irrigation event.

***Enter nutrient source (ie. Lagoon/Storage Pond ID, commerical fertilizer, dry litter, etc.)
Chapter 8: Safety—Type A

Security issues have become a way of life; whether it be at airports, going out in public, or working at a livestock facility. The 2007 foot and mouth outbreak in the United Kingdom and the more recent avian flu outbreak in several states underscore the fact that security at our facilities is vital. Integrators and individual farms may vary a bit in their practices. Be sure to learn and follow the rules for your site.

Agency representatives (SWCD, DEQ, Cooperative Extension) have additional practices that they must observe. These typically involve how many sites they can visit and restrictions on site visits after foreign travel or travel to an area with disease outbreak.

Accidents and injuries don’t just happen, they are caused. Behind every accident is a chain of events that leads up to an unsafe act, unsafe conditions, or a combination of both. Safety in the workplace should be everyone’s concern. Communication between supervisors and employees generates ideas and safety awareness that leads to accident prevention. Safety programs, safety manuals, and safety meetings are essential in providing the lines of communication that lead to a safe, accident-free workplace.

Dangerous Gases

Dangerous situations can be associated with five main gases that are produced in livestock and poultry buildings and manure storage structures. These gases are listed in Table 8-1, along with some of their characteristics. The density term “heavier than air” means these gases settle to the floor and are in the highest concentrations at that level. “Lighter than air” means these gases will concentrate near the ceiling. All of these are colorless. The Occupational Safety and Health Administration (OSHA) has established a permissible exposure limit (PEL) for each of these gases except methane, for which there are no specific exposure limits.

<table>
<thead>
<tr>
<th>Gas</th>
<th>Odor</th>
<th>Density</th>
<th>Health Effects</th>
<th>PEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia (NH₃)</td>
<td>Pungent</td>
<td>Lighter than air</td>
<td>Irritation to eyes and nose. Asphyxiating at high levels</td>
<td>50 ppm¹</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>None</td>
<td>Heavier than air</td>
<td>Drowsiness, headache. Can be asphyxiating.</td>
<td>5,000 ppm¹</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>None</td>
<td>Heavier than air</td>
<td>Headache, chest pains, potential for problems with developing fetuses. Can be asphyxiating.</td>
<td>50 ppm¹</td>
</tr>
</tbody>
</table>

Table 8-1. Characteristics and Effects of Gases Produced in Livestock Buildings and Manure Storage Structures

Describe the health effects of gases associated with livestock buildings and manure storage.
Table 8-1. Characteristics and Effects of Gases Produced in Livestock Buildings and Manure Storage Structures (continued)

<table>
<thead>
<tr>
<th>Gas</th>
<th>Odor</th>
<th>Density</th>
<th>Health Effects</th>
<th>PEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen Sulfide (H₂S)</td>
<td>Rotten-egg smell</td>
<td>Heavier than air</td>
<td>TOXIC: causes headache, dizziness, nausea, unconsciousness, death.</td>
<td>20 ppm²</td>
</tr>
<tr>
<td>Methane (CH₄)</td>
<td>None</td>
<td>Lighter than air</td>
<td>Headache, asphyxiant, explosive in 5% to 15% mixture methane with air.</td>
<td>None³</td>
</tr>
</tbody>
</table>

¹PPM averaged over an 8-hour workday (time-weighted average: TWA).
²Ceiling concentration, not TWA.
³Recommendation is to keep oxygen concentration above 19.5%

**Ammonia**

Ammonia (NH₃) is released from fresh manure and urine and during anaerobic decomposition. Ammonia levels tend to be high in buildings where manure is not regularly and thoroughly removed. Examples include buildings with litter, solid floors, or scrapers where manure is spread over the floor. Heated floors can increase ammonia release. Furthermore, when pH levels are higher than 8.0, ammonia is more susceptible to being released. Ammonia is very soluble in water; therefore, liquid manure systems tend to release less ammonia. Building ventilation also affects ammonia levels in the air. Concentrations in ventilated hog buildings have been measured as high as 35 ppm (slightly irritating to the eyes and nose) and in unventilated buildings as high 176 ppm, which can produce extreme discomfort.

**Carbon Dioxide**

Death of animals in closed confinement buildings following a ventilation-equipment failure (such as a power failure) is due in part to excessive carbon dioxide. Carbon dioxide (CO₂) is released by unvented heaters, through livestock respiration and manure decomposition. In fact, most of the gas in bubbles coming from stored manure or lagoons is CO₂. Vigorous agitation of stored manure can also release a large amount of carbon dioxide in a short time period.

**Carbon Monoxide**

Carbon monoxide (CO) can cause workers to develop headaches and experience chest pain. Pregnant women should be aware of the potential health hazard this gas poses to a developing fetus. Carbon monoxide is rare in confinement buildings, but can accumulate in areas with poor ventilation such as swine farrowing rooms and nursery buildings. Evidence of carbon monoxide overexposure among livestock may first appear as aborted litters and stillbirth. The main sources of CO are heaters (LP-fired, radiant brooder, or space heaters).
Hydrogen Sulfide
Hydrogen Sulfide ($H_2S$) is the most toxic gas generated from the storage of liquid manure. Exposure to 200 ppm for an hour can cause headaches and dizziness; 500 ppm for 30 minutes can cause severe headaches, nausea, excitement, or insomnia. High concentrations of 800 to 1,000 ppm can cause immediate unconsciousness and death through respiratory paralysis unless the victim is moved to fresh air and artificial respiration is immediately applied. Be aware—even the characteristic rotten-egg smell of hydrogen sulfide does not give adequate warning. The sense of smell is rapidly fatigued by the gas and high concentrations do not give a proportionately higher odor intensity. Also note that dangerous concentrations can be released by agitation of stored liquid manure. Concentrations reaching 200 to 300 ppm have been reported in buildings a few minutes after starting to pump waste from a storage pit and can be as high as 800 ppm during vigorous agitation.

Methane
Methane (CH$_4$) is a product of manure decomposition under strict anaerobic conditions, such as those found in an anaerobic or biogas digester. It is insoluble in water, lighter than air, and thus will accumulate in stagnant air corners in the top of enclosed pits or buildings. Methane is not toxic, but at high concentrations may cause an asphyxiating environment. Methane concentrations in confinement housing is normally well below the levels that may be explosive (Table 8-1). However, explosions attributed to methane have occurred around manure storage pits.

First Aid for Victims of Manure-Gas Asphyxiation
Do not attempt to rescue a victim from a hazardous gas situation unless you are protected with a supplied air-breathing apparatus.

1. Have someone telephone for an emergency medical (rescue) squad, informing them there is a “victim of toxic gas asphyxiation.”
2. If the victim is free from the immediate area of danger and there is no personal threat to life, check for breathing (with the victim on his/her back). If there is no breathing, give four quick breaths and check for a pulse.
   - *If there is a pulse*, continue mouth-to-mouth breathing every 5 seconds (12 per minute).
   - *If there is no pulse*, start CPR (cardio-pulmonary resuscitation) immediately.

Training courses for rescue breathing and CPR are available through local Red Cross and Cooperative Extension Service centers. These courses provide the training and practice necessary to perform CPR.

Effect of Air Quality on Human Health
Health problems associated with poor air quality include coughing, phlegm production, wheezing, chest tightness, headaches, shortness of breath, eye irritation, sneezing, runny nose, and nasal congestion. Problems are usually greater the more time a worker
spends in the presence of the contaminant and the greater the concentrations of airborne contaminants. In addition, some people are more susceptible than others.

Health problems may be chronic (lasting a long time) or acute (severe but short term). Since chronic and acute problems can be mistaken for other health problems, such as the flu or allergies, the work environment is often overlooked as a cause of the symptoms and precautions are therefore not taken.

**Safety Precautions with Manure Storage**

You should consider safety when constructing, operating and managing animal waste management systems. The following major safety points should be considered when installing and operating manure equipment, structures, or systems:

1. Do not enter a manure storage pit or any kind of tank unless following procedures for entering a confined space.
2. When agitating a manure storage structure, always have at least one additional person available to seek help if trouble occurs.
3. Properly designed and operated ventilation systems can reduce the concentration of gases within the building, thereby improving animal performance and minimizing health problems of workers.
4. For earthen storage ponds and lagoons, erect signs: “Danger—Manure Storage.” Additional precautions include a minimum of one lifesaving station equipped with a reaching pole and a ring buoy on a line.
5. Get help before attempting to rescue livestock that have fallen into a manure storage structure.
6. Permanent ladders on the outside of above-ground tanks should have locked entry guards or the ladder should not be able to be reached from the ground.
7. Never leave a ladder standing against an above-ground tank or grain bin.
8. All push-off platforms need a barrier strong enough to stop a slow-moving tractor.
9. If manure storage is outside the livestock building, use a water trap or other device to prevent gases from the storage structure from entering the building.
10. Don’t smoke, weld, or use an open flame in confined, poorly ventilated areas where methane can accumulate. Electric motors, fixtures, and wiring near manure storage structures should be kept in good condition to prevent a spark from igniting the methane.

**Vehicle Safety**

Only employees with a current, valid N.C. driver’s license should drive vehicles. In the case of specialized vehicles, only trained operators should operate the vehicles. The driver of the vehicle should inspect the vehicle prior to operating it.
General Vehicle Operation
1. All vehicles should be operated within the legal speed limit at all times or at a lower speed where conditions warrant.
2. Vehicles should not be used to transport unauthorized personnel.
3. The driver should be familiar with the capacity and required clearances for safe use of the vehicle.
4. Objects or persons being transported should be located so that they do not obstruct the driver’s view.
5. Always know the proper operating procedures for each piece of equipment used.

Tractor Safety
Tractors are a major source of injury at farms. A number of basic safety recommendations are important:
1. Seat belt should be worn at all times.
2. Drive the tractor with care and at safe speeds when operating over rough ground, crossing ditches or slopes, and turning corners.
3. Use the handhold and step plates when getting on and off the tractor to prevent falls.
4. Do not park the tractor on a steep slope.
5. Shut off the engine and apply the parking brake before getting off the tractor.
6. Never approach tractor when it is operating.
7. Stop engine to fill fuel tank.
8. Do not operate equipment with PTO guard missing.
9. Do not drive straight up and down inclines.
10. All lifts should be lowered to ground when parked.
11. No passengers allowed.
12. Ensure you can see what is in front of you.
13. If you suspect a problem with the tractor, shut off engine immediately.
14. When using front end loader, travel at a safe speed and always keep load as close to ground as possible.
15. When hooking equipment, do not straddle hitch/draw bar, etc when guiding driver back.
17. Never mow unclean or unleveled ground.
18. Tractors must be equipped with a rollover protection system (ROPS).
19. Hitch only to the drawbar and hitch points recommended by the manufacturer.
20. Never operate a tractor or other farm vehicle that you are not familiar with. Have an experienced person show you how to operate the vehicle and all its controls.

Equipment
All employees shall be instructed in the proper use and maintenance of any farm equipment, machinery, or mobile equipment that they may be required or expected to utilize in the performance of their duties.
Yard Maintenance Equipment

All yard maintenance equipment (i.e. mowers, trimmers) should be maintained in good operating condition. Keep blades sharp and equipment greased. Watch for equipment wear, which could result in possible injury to operator and other personnel. Never leave a running mower unattended. Always wear safety goggles, hearing protection, and proper footwear when operating this equipment.

Power Take-Off (PTO) and Machine Guarding

1. Refer to the safety section of owner’s manual.
2. Stay clear of rear of vehicle during operation.
3. Do not wear loose fitting clothing, scarves, or jewelry that could get caught in the PTO.
4. Tie back long hair.

Machine guarding is used to keep people and machines separated. Any time a machine has moving parts, such as augers, spinning shafts, rotating blades, etc. those parts need to be protected to keep hands, feet, clothing, or anything else which could result in bodily injury from becoming trapped in them.

The best method is to have a guard that encloses or covers the moving part so that entanglement is impossible. Guards of this type include covers such as those on “V” belts or the PTO guard on a tractor or PTO shafts on mower decks. These guards should be checked periodically for tightness or missing bolts. If the guard is damaged, it should be replaced before operating the equipment again.

Hydraulic Systems

1. Do not open pressurized lines. Hydraulic fluid can cause severe burns, eye injury, or skin irritation.
2. Search for leaks in the line using a piece of cardboard or wood, not your hands.
3. If anyone is injured by hydraulic fluid, administer first aid, then contact a physician.
4. Stay clear of leaky hydraulic lines.
5. Have system repaired by a knowledgeable technician.

Electrical Safety

All employees must lock-out/tag-out any piece of equipment they are working on where the unexpected energization, startup, or release of stored energy could occur. In case of electrocution, turn off power to the electrical source or use an insulated implement, such as a piece of wood, to separate the victim from the source. Do not attempt to pull a victim away from the electrical source with your bare hands.

The Lockout/Tagout (LOTO) procedure is used to prevent injury from machines and tools with moving parts. It requires that all moving parts have the energy source that powers the tool or equipment to be at “zero energy state”. What this means is that the energy source which powers or makes the tool or machine operate must be disconnected or de-energized. With electrical equipment, either unplug the machine, shut off the switch or trip...
the breaker in the electrical panel. Air driven tools would be disconnected at the air source. Hydraulic operated equipment must have the valves or lines “blocked”. In other words, any energy source to operate or run a piece of equipment or tool must be effectively shut-off or disconnected. The term LOTO (lockout/tagout) comes from the practice of placing locks on the lever or handle which controls the energy to industrial tools and equipment once the handle is in the off position. This is the preferred method of insuring that power cannot be accidentally turned back on while the item is being repaired or serviced. In cases where the energy source cannot be locked in the off position, a tag must be placed by the switch or control where the power is turned off to let anyone know that the power is turned off for the purpose of maintenance or service. The tag is used only when the energy source can’t be locked out and usually has words such as: “DO NOT TURN ON” or “DO NOT OPERATE”. Tags and/or locks used for de-energizing equipment or tools may be removed only by the person that applied them.

Another point to remember is that some pieces of equipment may be operated or driven by more than one energy source. For example, an auger motor, which is electrically operated, also has a “mechanical spring” inside the housing, which must be de-energized by clamping the spring before removing the motor cover. To be safe, only employees who have the knowledge and training required to perform the maintenance or service should be assigned the task of working on a piece of equipment or using a tool. If in doubt...ASK YOUR MANAGER OR SUPERVISOR FOR ASSISTANCE.

**LOTO Procedure:**

1. Turn breaker to the “off” position.
2. Place lockout device over breaker and screw down tightly to switch.
3. Place lock on hole closest to the breaker switch. Place all keys in pocket of person performing maintenance work.
4. Tag lockout device with name and date.
5. Second person needing to lockout on same breaker must place lock in second hole and tag also. Remember to place keys in pocket of person performing maintenance.
6. Both persons performing maintenance on system must wait until both are complete to energize system.

**Lagoon Safety**

Working safely on or around lagoons and waste storage ponds is the responsibility of each employee. No one should be permitted near a lagoon if they cannot swim. All persons who are on a lagoon in a boat should have on personal flotation devices (PFD or lifejacket) of the proper type. In addition, an individual should be on the bank to call for assistance if there is trouble in the boat. All lagoons should have a throw buoy available at a key place where employees are typically working around the lagoon, such as irrigation pumps, recycle pumps, and level markers.
Where vehicle traffic has potential to come near lagoons, warning signs should be posted, and physical barriers erected to keep farm vehicles and tractors from going into the lagoon. Lagoons and storage ponds are also sources of manure odors. Although rarely are the fumes as concentrated as in the confinement houses, they can occasionally be strong and unpleasant. Individuals with asthma or other breathing difficulty should avoid working close to a lagoon. Lagoon banks must be maintained, so follow precautions mentioned above for tractors and mowers on sloping sites. When walking around a lagoon, be alert for venomous snakes, fire ants, and holes from burrowing animals.

**Heat Injury Prevention**

There are several things that can be done to reduce the risk of injury to employees while working in hot conditions. Below are some helpful hints for scheduling tasks during hot days.

1. Try to reschedule tasks so that the most difficult and physically demanding ones can be completed in the early morning or late afternoon hours when temperatures are lower.
2. Keep fluids available to all employees and make sure that the employees understand the need for drinking frequently. If you wait until you “feel thirsty” before drinking, you probably waited too long. Dehydration begins before the body feels thirsty in hot conditions. Drinking on regular intervals is the best way to prevent dehydration.
3. Take more frequent breaks, especially during the hottest parts of the day.
4. Learn the symptoms of different heat injuries and keep a close watch on your fellow employees for signs of any of these.

**Personal Protective Equipment (PPE)**

Employees should use the appropriate personal protective equipment, or protective devices, provided for their work. Before starting work, these items should be inspected by the employee to ensure that they are in safe operating condition. These items include, but are not limited to:

1. Hard hats should be worn when appropriate.
2. Hearing protection should be used, as needed, to reduce noise levels when working around generators and heavy equipment or when mowing and weed-eating.
3. Face shield or eye protection should be worn when operating shop tools, mowers and weed-eaters, and when working around chemicals. Rain suits may also be needed when performing duties with chemicals.
4. Safety belts/seat belts should be worn at all times in vehicles.
5. Approved welding goggles or helmets and gloves should be worn while welding, cutting, or both. Fasten clothing around the neck, wrists, and ankles.
6. Appropriate footwear, including steel-toed boots where needed.
Lifting and Carrying

Everyone should observe the following guidelines to avoid possible injury when lifting and carrying objects:

1. Set your feet far enough apart to provide good balance and stability (approximately the width of your shoulders).
2. Get as close to the load as practical, bending your legs at the knees, and bending at the hips to keep your back as straight as possible.
3. Straighten your legs to lift the object, and at the same time bring your back to a vertical position.
4. When lifting an object with another person, be sure that both individuals lift at the same time and let the load down together.
5. Do not carry loads above people. Do not hoist, lower, or move any person with a crane by allowing them to stand on the hook, or by any nonapproved method.
6. Do not stand under a suspended load or boom unless the nature of the work requires it.

Personal Hygiene

Wastewater contains pathogens (disease-causing organisms). Hence, good personal hygiene is very important!

1. Keep your hands away from your nose, mouth, eyes, and ears to avoid ingestion of wastewater.
2. Nonpermeable gloves should be worn when handling any equipment covered with wastewater or residuals.
3. Special care (e.g., protective, waterproof dressing) should be taken to keep any area of broken skin covered to avoid possible infection. If a worker suffers an injury which results in an open wound or laceration, they should be given a tetanus booster.
4. Wash hands thoroughly with soap before smoking, eating, drinking, or after work.
5. Work clothing should be changed and washed daily.
6. If contact with wastewater does occur, wash the area thoroughly with water and soap. Sponge any cuts with an antiseptic solution and cover with a clean, dry gauze dressing and waterproof adhesive.

Immunization

Each facility may want to consult a physician or the local health department to determine the need for immunizations for the employees working at the site. Adult tetanus and diphtheria should be given routinely every 10 years, or at shorter intervals when injury occurs.
Responsibilities of the Site Supervisor

The following should be the responsibility of the site supervisor:

1. Establish and supervise an accident prevention program and a training program that is designed to improve the skills and competency in the field of occupational safety and health for all employees.
2. Conduct preliminary investigations to determine the cause of any accident that results in injury. The results of this investigation should be documented for reference.
3. Establish and maintain a system for maintaining records of occupational injuries and illnesses.
4. Provide new employees with a safety orientation on the special hazards and precautions of any new job.
5. Conduct job briefings with employees before starting any job to acquaint them with unfamiliar procedures.
6. Issue necessary safety equipment and manuals.
7. Conduct periodic group safety meetings and audits with all employees.
8. Conduct monthly safety audits on the farm.

The Safety Program should include:

1. Procedures for reporting injuries, unsafe conditions, or unsafe practices
2. Use and care of personal protective equipment
3. Proper actions to be taken in the event of emergencies
4. Identification of hazardous gases, chemicals, or materials
5. Instructions on safe use of hazardous gases, chemicals, or materials and emergency procedures following exposure

CPR & First Aid Training

There should be a person available at all times with first aid training in:

- Bleeding control and bandaging
- Artificial respiration, including mouth-to-mouth resuscitation
- CPR
- Poisons
- Shock, unconsciousness, stroke
- Burns
- Sunstroke, heat exhaustion
- Frostbite, hypothermia
- Strains, sprains, hernia
- Fractures, dislocations
- Bites, stings
- Transportation of the injured
- Specific health hazards likely to be encountered by co-workers
Adequate, readily available first aid kits and supplies should be available on site. Emergency telephone numbers must be posted by telephones.

Suitable facilities for quick drenching or flushing of the eyes and body should be provided in areas where the eyes or body of any person may be exposed to injurious chemicals and materials.

**Responsibilities of the Employer (Safe Place Standards)**

The following are the responsibility of the employer:

1. The employer should furnish to each of his employees a workplace free from recognized hazards that may cause serious injury or death.
2. The employer should furnish and use safety devices, personal protective equipment, and practices that are reasonably adequate to render the employee workplace safe. The employer should do everything reasonably necessary to protect the life and safety of employees.
3. No employer should require an employee to be in any workplace that is not safe.

**Responsibilities of the Employee**

The following are the responsibility of the employee:

1. Each employee should keep themselves informed of safety requirements of the contents of the appropriate sections of this manual and any other safety manual provided by the employer and apply it to their work.
2. Each employee should perform their duties so as to provide safety to themselves and other employees.
3. An employee should request instruction where needed from the site supervisor if there is a question as to the safe performance of an assigned task.
4. Each employee should wear clothing that is suitable for the job performed.
5. Each employee is responsible to report to the site supervisor any unsafe condition, acts, or hazards.
6. Each employee should wear appropriate personal protective equipment.
7. If an employee has a specific allergy or medical condition that requires medication, it is wise to have someone know the location of the medicine in case of emergency. Examples would be an Epi-pen or glucose injector.

**Working in a Confined Space**

A confined space is defined as a space that has limited means of entry and exit, has an adequate size and configuration for employee entry, and is not designed for continuous worker occupancy. Pits, lift stations, and feed tanks can all classify as confined spaces. The tanks designed for storage, transport, and application of wastes are classified as confined spaces and fall under the jurisdiction of the North Carolina Department of Labor, which is the agency that enforces the Occupational Safety and Health Act (OSHA). Under
OSHA regulations, there are certain confined spaces that require a permit for entry. A permit-required confined space is defined as a confined space that has one or more of the following characteristics:

1. It contains or has the potential to contain a hazardous atmosphere;
2. It contains a material that has the potential for engulfing a worker;
3. It is configured such that it could trap or asphyxiate an occupant; or
4. It contains any other recognized serious safety or health hazard.

If a facility has permit-required confined spaces, to be in compliance with OSHA regulations, a written confined space entry program must be developed and implemented. Enclosed facilities which are used to handle wastewater or wastewater solids, such as the tanks and/or tanker trucks, would fall under the permit-required confined space regulations. Do not enter a permit-required confined space without proper training, equipment, and support personnel. (The confined space regulations can be found in the Code of Federal Regulations 29 CFR 1910.147)

When working in a space that does not require a confined space permit, the following safety actions must be taken:

1. Always assign a standby person to remain on the outside of the confined space. It is the standby person’s responsibility to be in constant contact (visually, verbally, or both) with the workers inside the confined space as long as anyone is in the space.
2. Wear ear protection, as needed. Noise within a confined space can be amplified because of the design and acoustic properties of the space.
3. Use only an air-supplying respirator, such as a self-contained breathing apparatus (SCBA) or a supplied-air respirator with an auxiliary escape-only SCBA in confined spaces where there is insufficient oxygen.

Fire Prevention and Protection

It is important to be fire conscious. Employees should be knowledgeable of the fire conditions at the site and operate accordingly. Poor site maintenance, worn or defective electrical systems, and welding and cutting may contribute to dangerous situations. The following precautions should be observed:

1. Do not smoke near equipment or fuel trailers. No open flame should be allowed near wastewater storage tanks. Combustible gases can accumulate and when vented to the surrounding area, may become explosive.
2. Do not tamper with or remove fire-fighting equipment from designated locations for purposes other than fire-fighting or rescue operations. Access to fire equipment should not be hindered. If fire extinguishers are used, they should be promptly recharged. Inspect fire extinguishers monthly to be sure they are in good operating condition.
A basic fire emergency plan should be developed. It includes:

1. Having all employees knowing that the first step is to call 911.
2. Know locations of all fire extinguishers.
3. Know exit points from all buildings and always keep them unblocked.
4. Have an assembly point for all employees.

Fire extinguishers should be inspected annually. If discharged, they must be refilled and inspected or discarded. At least one portable fire extinguisher must be located not less than 10 feet, nor more than 25 feet, from any flammable material. All employees must be trained in the location and operation of portable fire extinguishers.

**Review Questions**

1. List some gases that may cause concern at an animal operation, and some methods to minimize risk and exposure to these gases.

2. Name some system components at an animal operation where safety checks are necessary.

3. What is a confined space?

4. What are the major safety roles of the site owner, manager, and employee?

5. List personal protective equipment that is needed to ensure a safe farm working environment.
Chapter 9: Emergencies and Catastrophes—Type A

When emergencies and catastrophes involving the waste management system occur, owners and operators must be prepared to respond. A well-coordinated, timely response can minimize adverse impacts on public health and the environment. A poor response can lead to personal injuries, economic losses, negative public reaction, increased scrutiny by regulatory agencies, and an increased likelihood of enforcement or disciplinary action.

This chapter covers protocols and procedures for handling emergencies and catastrophes involving the waste management system. These events fall into two general categories: 1) those related to spills or discharges of animal waste; and 2) those related to massive or catastrophic animal mortality disposal.

Animal Waste Related Emergencies

Animal waste related emergencies are often the result of human error and equipment failure, such as over-application of waste, application to saturated, frozen, or snow-covered fields, breaks in pipes or other failures of distribution equipment, and failure of lagoons or other storage structures. Natural catastrophes such as heavy rainfall, flooding, and hurricanes can also contribute to these emergencies.

The primary goal of this training has been to prepare you to operate an animal waste management system as a non-discharge system. As emphasized throughout this training, discharges of animal waste are prohibited. The Division of Water Resources does not and will not condone any discharge of waste from an animal operation to the surface waters as part of the CAMWP, or the land application of waste at levels above that specified by or in violation of the CAWMP. However, owners and operators must be prepared to handle animal waste related emergencies, whether imminent or in progress.

Imminent Emergencies: Lagoons with High Freeboard

Natural catastrophes such as hurricanes, heavy rainfall, and flooding can cause lagoon levels to be higher than that required to be maintained for structural stability. Structural stability is lost when the lagoon level exceeds the 25-year, 24-hour storm storage level of the lagoon (Figure 9-1). Remember from Chapter 2 that a 25-year, 24-hour storm is a storm that delivers from 5 to 9 inches of rain (depending on the region of the state) in one 24-hour period.

In this situation, a discharge or spill has not yet occurred. If ignored, however, this emergency will probably result in a spill or leak within a short time.
Plan of Action for High Freeboard—30-Day Draw Down

When facilities are identified with waste in their lagoon(s) below the level required to be maintained for structural stability, but not adequate to also retain the 25-year, 24-hour rainfall event, the producer will be required to submit a Plan of Action for High Freeboard—Thirty Day Draw Down within 48 hours to lower and maintain the lagoon level to a point below that needed for both structural stability and the 25-year, 24-hour rainfall event.

The producer should consider pump and haul to another facility that can adequately manage the waste in accordance with its CAWMP as part of this plan.

If the producer’s plan cannot adequately demonstrate the ability to reduce the lagoon level below that required for both structural stability and the 25-year, 24-hour rainfall event within 30 days (or before the lagoon level is projected to rise to a level above that required for structural stability if less than 30 days) without the removal of animals from the facilities, then removal of animals must be a component of this plan.

The number of animals removed must be to a level at which the producer can adequately demonstrate the ability to manage the lagoon level below the level needed for both structural stability and the 25-year, 24-hour storm event.

Plan of Action for High Freeboard—Five Day Draw Down

When facilities are identified with waste in their lagoon(s) above the level required to be maintained for structural stability, the owner is required to submit a Plan of Action for High Freeboard—Five (5) Day Draw Down within 24 hours to lower and maintain the lagoon level to a point below that needed for both structural stability and the 25-year, 24-hour
rainfall event. The owner must also submit a Plan of Action for High Freeboard – Thirty Day Draw Down at the same time.

The owner should consider pump and haul to another facility that can adequately manage the waste in accordance with its CAWMP as part of their plan.

If the owner’s plan cannot adequately demonstrate the ability to reduce the lagoon level below that required for structural stability within 5 calendar days without the removal of animals from the facilities, then immediate removal of animals must be a component of this plan.

The number of animals removed must be to a level at which the owner can adequately demonstrate the ability to manage the lagoon level needed for both structural stability and the 25-year, 24-hour storm event.

**Forms Required**

When completing a Plan of Action for High Freeboard, an owner must use the following forms developed and made available by DWR:

- Plan of Action for High Freeboard at Animal Facilities Cover Page (POA Cover Page); and
- Plan of Action for High Freeboard at Animal Facilities – Five (5) Day Draw Down Period (POA 5 day); and/or

Copies of these forms are provided in Appendix G.

Owners may need to consult a certified technical specialist for assistance when completing the forms, which require the following information:

- Lagoon design information, including:
  - Top of dike surface area
  - Designed 25-year, 24-hour storm storage and structural freeboard
  - Lagoon storage volumes
- Volume of wash water
- Excess rainfall over evaporation
- Current lagoon liquid level according to lagoon marker
- Current herd population
- Current waste analysis report
- Certified Animal Waste Management Plan
- Irrigation records

The Plan of Action must be submitted to the appropriate DWR regional office, within the time frames stipulated above. If an owner does not provide a plan demonstrating their ability to manage the lagoon level in the time periods outlined above, DWR will issue a Notice of Violation and proceed with enforcement action (fines).
Emergencies in Progress: Spills and Discharges

If animal waste from your operation is leaking, overflowing, or running off the site, a spill or discharge of animal waste is in progress and you must take immediate action. You must NOT wait until waste reaches surface waters or leaves your property to consider that you have a problem. You must make every effort to ensure that this does not happen, by immediately implementing the waste management system’s emergency action plan.

As we learned in Chapter 3, an emergency action plan is a required component of the certified animal waste management plan. Using the resource lists in Appendix D, you must develop an emergency action plan specific to your waste management system.

Emergency action plans must follow this format (see an example in Appendix G):

- Stop the release of waste
- Assess the extent of the spill and note any obvious damages
- Contact the appropriate agencies
- Implement procedures to rectify the damage and repair the waste management system

Emergency Action Plans

1. Stop the release of waste. Depending on the situation, this may or may not be possible. Suggested responses to several possible problems are listed below:
   a. Lagoon overflow -- possible solutions are:
      1. Add soil to berm to increase elevation of dam.
      2. Pump wastes to fields at an acceptable rate.
      3. Stop all flows to the lagoon immediately.
      4. Call a pumping contractor.
      5. Make sure no surface water is entering storage structure.
   b. Runoff from waste application field – actions include:
      1. Immediately stop waste application.
      2. Create a temporary diversion to contain the waste.
      3. Incorporate waste to reduce runoff.
      4. Evaluate and eliminate the reason(s) for the runoff.
      5. Evaluate the application rates for the fields where runoff occurred.
   c. Leakage from the waste pipes and sprinklers – actions include:
      1. Stop recycle (flushing system) pump.
      2. Stop irrigation pump.
      3. Close valves to eliminate further damage.
      4. Repair all leaks prior to restarting pumps.
   d. Leakage from base or sidewall of lagoon or earthen storage structure (often this is seepage rather than flowing leaks) – actions include:
      1. Dig a small sump or ditch away from the embankment to catch all seepage, put in a submersible pump, and pump back to lagoon.
      2. If burrowing animals are creating holes, trap or remove the animals and fill holes, compacting with clay type soil.
3. Have a professional evaluate the condition of the sidewalls and lagoon bottom as soon as possible.

2. Assess the extent of the spill and note any obvious damages.
   a. Did the waste reach any surface waters? If so, how much?
   b. Approximately how much was released and for what duration?
   c. Any damage noted, such as employee injury, fish kills, or property damage?
   d. Did the spill leave the property?
   e. Does the spill have the potential to reach surface waters?
   f. Could a future rain event cause the spill to reach surface waters?
   g. Are potable water wells in danger (either on or off the property)?

3. Contact appropriate agencies.
   a. During normal business hours, call your DWR regional office; after hours, call this emergency number: 1-800-858-0368. Your phone call should include:
      1. Your name, facility, telephone number;
      2. Details of the incident from item #2 above;
      3. Exact location of the facility;
      4. Location or direction of movement of the spill;
      5. Weather and wind conditions;
      6. Corrective measures taken; and
      7. Seriousness of the situation.
   b. If spill leaves property or enters surface waters, call local Emergency Management Service (EMS).
   c. Instruct EMS to contact the county Environmental Health Department.
   d. Contact your local Cooperative Extension center, local SWCD office, and local NRCS office for advice/technical assistance.
   e. If none of the above works, call 911 or the Sheriff’s Department and explain your problem to them. Ask them to contact the agencies as listed above.

4. Implement procedures as advised by DWR and technical assistance agencies to rectify the damage, repair the system, and assess the waste management system to prevent another release.

The emergency action plan must also include provisions for emergency spreading or transfer of waste from all waste storage structures in the system. This may include emergency pumping or spreading (to prevent overtopping of a storage structure) during periods when the soil or crop conditions are not conducive to normal spreading or application.

You must contact DWR for guidance and authorization to land apply waste in this situation. You should consider which fields are best able to handle the waste. If you must choose another location for application, consider the limitations that may be involved with the transfer of waste to that site and evaluate the application considerations at that location.
The emergency action plan must be available and understood by all employees at the facility, as accidents, leaks, and breaks can happen at any time. The main points of the plan (order of action) along with the relevant phone numbers must be posted by all telephones at the site. A copy must also be available in remote locations or vehicles if the land application sites are not close by the facility office.

It is the responsibility of the owner or manager of the operation to ensure that all employees understand the circumstances that constitute an imminent danger to the environment or health and safety of workers and neighbors. Employees must be able to respond to such emergencies and notify the appropriate agencies of conditions at the facility.

**Notice of Discharge of Animal Waste**

Owners of animal facilities, as well as municipal and industrial facilities, are required by law to notify the news media in the event of discharges and spills.

1. In the event of a discharge of 1,000 gallons or more of animal waste that reaches surface waters of the State, the owner or operator must:
   a. Issue a press release to all print and electronic media that provide general coverage in the county where the discharge occurred setting out the details of the discharge.
   b. Issue the press release within 48 hours of determining that the discharge reached the surface waters.
   c. Retain a copy of the press release and a list of the news media to which it was distributed for at least one year after the discharge.
   d. Provide a copy of the press release and the list of the news media to which it was distributed to any person upon request.

2. In the event of a discharge of 15,000 gallons or more of animal waste that reaches surface waters of the State, the owner or operator must:
   a. Publish a notice of the discharge in a newspaper having general circulation in the county in which the discharge occurred, and in each county downstream from the point of discharge that is significantly affected by the discharge (the Secretary of the Department of Environment and Natural Resources will determine, at the Secretary’s sole discretion, which counties are significantly affected by the discharge and shall approve the form and content of the notice and the newspapers in which the notice is to be published).
   b. Publish the notice, which must be captioned “NOTICE OF DISCHARGE OF ANIMAL WASTE”, within 10 days after the Secretary has determined the counties that are significantly affected by the discharge and approved the form and content of the notice and the newspapers in which the notice is to be published.
   c. File a copy of the notice and proof of the publication with the Department of Environment and Natural Resources within 30 days of the discharge.
   d. Issue a press release as described above, in addition to publishing the notice of discharge.

Examples of a press releases and a notice of discharge are included in Appendix G.
Mandatory Reporting by Government Employees

Senate Bill 1217 states that certain violations are immediately reportable to the Division of Water Resources. The reporting requirement applies to any employee of a state agency or a unit of local government and is not limited to technical specialists who perform operations reviews. The bill requires any state or local government employee who is “lawfully on the premises and engaged in activities relating to the animal operation” to immediately report the following violations:

1. Any direct discharge of animal waste into waters of the state.
2. Any deterioration or leak in a lagoon system that poses an immediate threat to the environment.
3. Failure to maintain adequate storage capacity in a lagoon that poses an immediate threat to public health or the environment.
4. Over spraying animal waste either in excess of the limits set out in the animal waste management plan or where runoff enters waters of the state.
5. Any discharge that bypasses a treatment or collection system.

Reports of the violations are to be made to the owner or operator of the animal operation and the DWR regional office. Employees of federal agencies are encouraged, but not required, to make immediate reports of violations.

Animal Mortality Related Emergencies

As discussed in Chapter 3, proper animal mortality disposal is a part of an animal operation’s routine management responsibilities and is a requirement of the CAWMP. Disease and natural disasters like flooding, hurricanes, and tornadoes, however, can result in massive animal loss in a very short period of time. Routine methods of dead animal disposal are usually not sufficient for handling large amounts of dead animals.

Proper disposal of dead animals during an emergency or catastrophic event will prevent potential public health problems resulting from large numbers of dead and decaying animals including the spread of harmful pathogens, groundwater and surface water contamination, and pest control.

The N.C. Department of Agriculture and Consumer Services Veterinary Division is the lead state agency to oversee animal disposal as regulated under N.C. General Statute 106-403, Disposition of Dead Domesticated Animals. The State Health Director and, by extension, the Local Health Director in each county, are charged with preventing health risks and disease as well as promoting a safe and healthy environment. To the extent that dead animals become a threat to human health, the State and Local Health Director have broad authority to investigate and act on matters to protect health.
Emergency Plans for Catastrophic Animal Mortality
All animal operations require specific plans for dead animal disposal in the event of catastrophic mortality. Catastrophic animal mortality in North Carolina is most likely to be caused by natural disasters, such as hurricanes and floods, and associated electrical outages.

A different set of emergency plans may be needed for animal mortality disposal associated with a disease related emergency, which would be managed by the State Veterinarian.

Assistance with planning and training for animal emergencies is available from the North Carolina State Animal & Agriculture Response Team (SART). Dedicated to preparing, planning, responding and recovering during animal emergencies, SART is a public-private partnership that provides technical assistance in the event of an emergency or catastrophe. It also offers training programs designed to promote safe, environmentally sound and efficient responses to animal emergencies. Many counties also have a County Animal Response Team (CART).

Disaster-Related Catastrophic Animal Mortality
These guidelines are intended to address dead animal disposal during a declared emergency, which the Governor can declare with or without a federal declaration. They are not intended to take the place of dead animal disposal that occurs under the normal permitted operation of a farm. Additional recommendations for managing disaster related catastrophic animal mortality may be found in the NCDA&CS documents, Update on Management of Catastrophic Mortalities (November 2016) and NCDA&CS Mass Animal Mortality Management Plan for Catastrophic Natural Disasters (October 2016). These documents can be found in Appendix G.

Composting Standards
Composting of mass animal mortalities has emerged as a first choice disposal option based on the highly successful use for disease management and recovery during the U.S. Highly Pathogenic Avian Influenza response of 2015 and 2016 in the Midwest. The NCDA&CS has put forth significant efforts in developing processes and capabilities related to composting of mass mortality. This disposal method has proven to be very effective in helping farms recover from damage sustained in Hurricane Matthew while being protective of public health and the environment.

When composting is determined to be the disposal method of choice, NCDA&CS recommends following the environmental guidance document entitled North Carolina Guidance for Composting of Mass Animal Mortality (October 2016). See Appendix G.

Burial Standards
When burial is determined to be the disposal method of choice, an attempt should be made first to bury the dead animals on the farm according to the following guidelines:

1. The bottom of the hole where dead animals are to be buried should be 3 feet above the seasonal high water table wherever possible and at least 12 inches above the
seasonal high water table. Contact the local NRCS office or county Environmental Health Department for assistance in determining the seasonal high water table.

2. Standing water in the hole does not prevent animal burial as long as the bottom of the hole is at least 12 inches above the seasonal high water table, not in an area of standing water, and the other conditions for proper burial are met.

3. There must be at least 3 feet of soil covering any buried animal. This can be interpreted to mean soil mounded over the animals above the adjacent ground level.

4. The burial site must be at least 300 feet from any existing stream or public body of water.

5. The burial site must be at least 300 feet from any existing public water supply well.

6. The burial site must be at least 100 feet from any other type of existing well.

7. The burial site cannot include any portion of a waste lagoon or lagoon wall.

8. In the case where the burial site is in a waste disposal sprayfield, the burial site is not available for subsequent waste spraying until a new viable crop is established on the site.

9. The burial site shall be located so as to minimize the effect of stormwater runoff.

10. Burial is not permitted in the tiled area of an under drained field.

11. A record of the location of the approved site (GPS latitude and longitude coordinates if available), the burial history of each burial site to include the date, species, head count, and age must be kept by the owner and reported to the county Environmental Health Department who will in turn report this information to the DWR Water Quality Regional Operations Section located within the appropriate regional office.

12. Farm owners and operators are encouraged to consider measures that could be taken prior to an imminent emergency that could reduce the impact on the farm and the environment.

**Collective Burial Site**

A collective burial site may be designated to serve one or more counties in the event of a large-scale emergency whereby individual farm sites are not available. The responsibility for disposal of dead animals remains with the owner, lessee, or person in charge of any land upon which any domesticated animals die. The county or municipality should identify an appropriate burial site(s) with the capacity to bury up to 5 percent of the steady state live weight of livestock in that jurisdiction. The use of an existing county or municipal landfill as a dead animal burial site is legal and preferred.

**Incineration**

Other options for animal mortality disposal may include incineration. Incineration has been approved as a method of mortality disposal, and cost share options are available through local Soil and Water Conservation District offices. Usually incineration is not able to handle large amounts of dead animals.
Review Questions

1. What format should your emergency action plan follow?

2. What should be done when facilities are identified with waste in their lagoon(s) above the level required for structural stability? When facilities are identified with waste in their lagoon(s) below the level required to be maintained for structural stability, but not adequate to also retain the 25-year, 24-hour rainfall event?

3. What items need to be available in order to complete the Plan of Action for High Freeboard forms?

4. What is required of animal facilities, as well as municipal and industrial facilities, in the event of discharges and spills?